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ABSTRACT

Designed to provide a link between academic thought and research and the practice of teaching, this monograph explores the appropriate educational response to technological change. The central argument of this study is that future job opportunities will lie essentially with low tech jobs, i.e., traditional, basic, industrial jobs, rather than the more glamorous high tech jobs, even in high tech industries. Various approaches to technological change are discussed, including the deterministic approach, the dialectic approach, and Luddism. Also discussed are technological cycles; the Silicon Valley model; the gender implications of technological change; and the influence of high tech on education, including high tech/low tech jobs and the educational response. Following a list of references, five additional readings are included: (1) "Computerization--Taylor's Latest Disguise" (M. Cooley); (2) "Kentucky-Fried Money: The Banks" (A. Game and R. Pringle); (3) "High Technology, Employment and the Challenges to Education" (R. Gordon and L. M. Kimball); (4) "Computer Literacy and Ideology," (D. F. Noble); and (5) "Computers and Kids" (I. E. Reinecke). An 11-item annotated bibliography is also provided. (RP)

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High tech, low tech and education

PETER WATKINS

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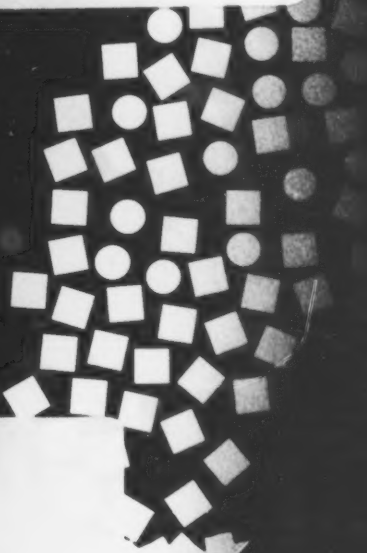

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Sociology of the school

High tech, low tech and education

PETER WATKINS

Deakin University

Deakin University

This book forms part of the EED423 *Sociology of the School* course offered by the School of Education in Deakin University's Open Campus Program. It has been prepared for the EED423 *Sociology of the School* course team.

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Series introduction

One feature of education is the gap that exists between academic interests and teacher practice. The theoretical and research interests of academics, on the one hand, are not readily available to teachers; the practical concerns of teachers, on the other hand, may not be taken account of by academics.

It is hoped that this series of monographs will provide a link between academic thought and research and the practice of teaching. Each volume in the series discusses contemporary educational issues and research in a way that can inform educational practice. They do not provide a set of prescriptive recommendations, but present a discussion of theory and research with the intention of highlighting the implications for educational practice in a way that can inform teachers.

The issues discussed in this monograph series include: the relationship between the political and economic institutions of society and the education system, suggesting a link between socio-political conditions and educational policies and programs; the experience of teaching, emphasising the importance of the self-concept of teachers in their socialisation into a professional role; ethnicity and multicultural policy, suggesting that these are best understood in terms of social class and what this might mean for teachers; a view of gender-related inequalities in education that suggests that these are best understood in terms of ideology about the family; the impact of new technology on society and the implications this may have for education; and the possibilities that confront the education system and the practising teacher.

It is hoped that these monographs will clarify some of the complex issues confronting educationists and will stimulate thought and discussion among teachers that will inform their own practice and add to the continuing debate.

David Dawkins.

David Dawkins
Course team chairperson

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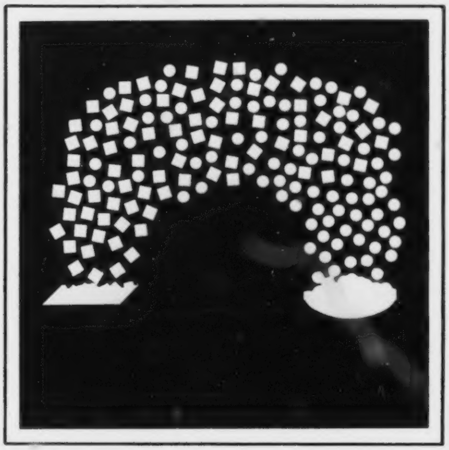
High tech, low tech and education



Introduction

The current romance with high tech is frequently reflected in the headlines of the major Australian city newspapers. So, for example, the feature page of the *Herald* has emblazoned across it '$75m. raised for high-technology' (*Herald*, 5 June 1985) or the *Age* proclaims 'Times are a changing with the help of technology' (*Age*, 15 January 1985). The *Australian* and the *Age* both have a regular weekly section headed 'Computers', but which usually looks at the changes and wonders being conjured up in the realm of high tech. In this popular context technological change is viewed as progress while progress is defined in terms of technological change.

Riche, Hecker & Burgan (1983) point out that there is no uniform or widely accepted definition of high tech. However, by examining the various definitions they argue that most definitions of high tech incorporate one or a combination of three factors. These are: firstly, the use of scientific and technical workers; secondly, a high expenditure on research and development; and, lastly, the nature of the product (Riche, Hecker & Burgan 1983, p. 51). Macdonald (1983), however, sees high tech as being associated with venture and risk capital. He claims that technology is high because of the 'relatively high risk involved, the possibility of high return, its high pace of change and its high information intensity' (Macdonald 1983, p. 331). Morrison (1983) indicates those industrial sectors where these definitions might come together. These sectors include:

> (1) *electronic technologies* for the creation, storage, retrieval, transmission, manipulation and control of information, including information for the automated control of mechanical systems;
>
> (2) *biological and biochemical technologies* related to medicine, industrial processing and material fabrication, agriculture, food processing, and energy conversion; and
>
> (3) *materials technologies* to achieve resource input efficiencies and/or to achieve the strength, weight, durability and size characteristics needed for traditional and nontraditional . . . applications.
>
> (Morrison 1983, p. 239)

Low tech jobs, in contrast, are traditional, basic industrial jobs. But it should be remembered that high and low tech are contested terms. What is now considered low tech most likely was thought of as high tech in the past. Now low tech jobs often do not require a higher education and they are becoming more frequently casual and part-time. While these types of jobs are often obscured by the glamour of high tech, the central argument of this monograph is that future job opportunities will lie essentially with low tech jobs rather than high tech jobs. Central to this argument is the proposition that even in high tech industries a large proportion of the jobs are low tech jobs. If this is the case, then what should be the appropriate educational response? But before we do this we need to look at the various arguments concerning technological change. One of these relates to technological determinism. Another argument claims that technological change evolves through dialectical relationships.

A major consideration of any discussion of technology is the examination of the concept of technological determinism. To do this we will firstly examine the works of Ellul and Winner. These will then be contrasted to the works of Marx and Weber who present a dialectical approach to technological change.

Deterministic and dialectic approaches to technological change

In this section two ways of looking at technological change will be presented. The first sees technology as an all embracing entity, autonomous and determining the direction both it and society will take. The second view sees human beings and technology in a dialectic relationship with human agency both being conditioned by and conditioning any technological innovations. In this dialectic, technology can be seen to mediate the interaction between labour and capital.

The deterministic approach

A certain view of technology sees technological development as evolving continuously in a fashion which is autonomous from human intervention and free from any value or ethical considerations but which contributes to the overall ordering of society. Technology is seen as having a life of its own and moving irresistibly in a determinate direction. This technological deterministic position is held, for example, by the French sociologist Jacques Ellul (see also Winner 1977). Ellul has been concerned in both *The Technological Society* (1964) and his more recent book, *The Technological System* (1980), to highlight what he sees as the technological domination of our present society. In this view technology determines the production and distribution of raw materials, determines the social structures of society and limits whatever choices we have. Thus technology is the determining factor in all social political and economic decisions. As Ellul puts it in his earlier *The Technological Society* (1964):

> In this decisive evolution, the human being does not play a part. Technical elements combine among themselves, and they do so more and more spontaneously. In the future, man will apparently be confined to the role of a recording device; he will note the effects of techniques upon one another, and register the results . . . Anything and everything which technique is able to produce *is* produced and accepted by the consumer. The belief that the human producer is still master of production is a dangerous illusion.
> (Ellul 1964, p. 93)

Technology is perceived to sweep inexorably forward, generating change and a set pattern of historical development within its own autonomous entity. This idea of autonomous technology is developed in greater depth in Ellul's later book, in which he explains that by autonomous technology he means that 'technology ultimately depends only on itself, it maps its own route, it is a prime and not a secondary factor, it must be regarded as an "organism" tending towards closure and self-determination: it is an end in itself' (1980, p. 125).

Ellul also goes to some lengths to point out that this autonomy ascribed to technological change also corresponds to the notion of functionality.

As a consequence it can be argued that:

> Each technological element is first adapted to the technological system and it is in respect to this system that the element has its true functionality, far more so than in respect to a human need or a social order . . . Performing this function, technology endures no judgment from the outside nor any restraint. It presents itself as an intrinsic necessity.
>
> (1980, p. 126)

Technology presented in this scenario is independent of human action and choice. Ellul, though, distinguishes between technology being neutral of human values and absolutely neutral. While it is divorced from humans, technology is not absolutely neutral; rather technology contains its own law and meaning. Technology, in this sense, is autonomous, objective and value free, separated from the whims and predilections of human beings. Thus Ellul puts forward the argument that technology 'is not an instrument that man can use as he likes. It has its own weight, which goes in technology's direction' (1980, p. 154). In this sense technology is reified with a force and sweep of its own. It is inevitably accepted, dictating the ways and means that it is used. Even though particular technologies may have disastrous effects on the human race their deployment is inherently unavoidable. For as Ellul puts it:

> We know the definite risk that humanity is made to run by the growth of bacteriological, chemical, and nuclear weapons, as well as by the general pollution of air and water, the domestic and agricultural use of countless chemical products . . . But none of this matters; we must, above all, use what technology puts in our hands.
>
> (Ellul 1980, p. 235)

Thus Ellul's argument stresses that technological forces are the decisive factor in determining the direction of change in the social and economic environment. The evolution of technology in a particular form is the independent variable which decides which path social change, the dependent variable, will take. The main agent of social change within society is an independent, autonomous technology which is separated from general social forces and considerations.

Winner, in his book, *Autonomous Technology* (1977), essentially agrees with the position which Ellul has taken up with regard to technological development. This position addresses the concern that technology has an independent, inexorable vitality, which eventually leads to the technological control of society. Society is dominated by a technological imperative requiring certain decisions to perpetuate the technological order itself rather than any human concerns which may direct the technology towards human needs and interests. This domination reflects a reverse adaptation whereby 'Technical systems become severed from the ends originally set for them and, in effect, reprogram themselves and their environments to suit the special conditions of their own operation' (Winner 1977, p. 227). In arguing the inevitability of the direction of technological change Winner draws not only on Ellul but also on the anthropological determinist A. L. Kroeber. Kroeber discounted any idea of the significance of people and human choice in the technological process. Kroeber held the 'conviction that inventions may be inevitable, within certain limits; that given a certain constellation and development of a culture, certain inventions must be made' (Winner 1977, p. 66). In this way, by fostering technology human beings have eventually lost control of their lives and choice becomes illusory because 'technology is now a kind of conduit such that no matter which aims or purposes one decides to put in, a particular kind of product inevitably comes out' (Winner 1977, p. 278).

The picture presented by Winner is that of a linear path of technological development. There is virtually no relationship between human beings and technology nor is there any consideration of values not subordinate to a technical rationality. Values relating to concerns for greater freedom, equity and justice are pushed aside. The neglect of any moral or ethical questions highlights the instrumentally functionalist progress of technology proceeding in a mechanical fashion. The presentation of technological change in such a predetermined, linear process precludes any consideration of human agency or practice which might render technology under control.

The technological determinist approach outlined above can take two directions in regard to its effect on human life, that of the optimist and that of the pessimist. The optimistic approach sees the march of technology as bringing about unprecedented human benefit. With the advent of new technology, according to the optimists, far more jobs will be created than will be lost. Not only will there be more jobs but these jobs will be set at a higher intellectual level. The repetitive routine jobs which had imposed so much drudgery on human beings during earlier periods of industrialisation will be eliminated. And if there is not the same number of jobs available as before, technology will bring about a new era of almost continual leisure. People will be able to pursue their hobbies and the arts without having to worry about work. Thus in Australia the Myers Report (Committee of Inquiry into Technological Change in Australia 1980) suggested that the emerging technological revolution is not only inevitable but also desirable, and should be encouraged and assisted. It argued that through the application of new technology Australia would be able to develop new products and processes from which would flow a new source of job opportunities (see also Watkins 1984).

In contrast, the pessimistic view of technological change sees the advance of technology as inevitably leading to massive unemployment. But the pessimists argue that, even in those jobs which do remain, there is still present an unremitting tendency for the jobs to be continually deskilled and degraded. In this scenario not only is physical, manual work deskilled and destroyed but also mental, intellectual work. So Braverman's view of the labour process in *Labor and Monopoly Capital* (1974) has been criticised as being basically deterministic even though he attempts to dispel this criticism by stressing that relations between technology and society are beyond the reach of any simple-minded 'determinism' (1974, p. 19). In particular Giddens (1982) and Mackenzie (1977) have highlighted a serious deficiency in Braverman's work. Mackenzie (1977, p. 249) notes that Braverman's work is 'devoid of dialectical under- or over-tones'. In support Giddens argues that there is a failure in *Labour and Monopoly Capital* to embrace a discussion which exposes the reactions and resistances of workers to technology, the technical division of labour and the ideology of scientific management (Giddens 1982).

The dialectic approach

The advocates of both the optimistic and the pessimistic view of technological change see the inexorable, unimpeded growth of technology. However, they deny that any implementation of technological change takes place at the direction of certain people and that any particular change takes place within a certain historical and social context. In this regard technology has to be seen as part of a social process deriving from particular historical milieu. It was for this reason Marx rejected any conception of technology and machinery which was historically and socially decontextualised. The analysis of machinery into basic components such as 'the lever, the inclined plane, the screw, the wedge, &c.' offered an 'explanation [which] is worth nothing, because the historical element is wanting' (Marx 1906, pp. 405–6). Rosenberg points out that for Marx 'new productive forces emerge, not exogenously or as some mysterious *deus ex machina*, but rather as a dialectical outcome of a larger historical process in which *both* the earlier forces and the relations of production play essential roles' (Rosenberg 1983, p. 38). Similarly, MacKenzie (1984) emphasises that technological change was, for Marx, a two-sided dialectical struggle. For 'Capital uses machinery not only strategically . . . but also for precise tactical purposes. Where workers' . . . militancy poses a threat to valorization, capital can counter by promoting the invention and employment of machinery to undermine workers' power' (1984, p. 488). This dialectical relationship between technology and the social and historical structures which both enhance and constrain the direction and rate of technological change is also well caught by Giddens (1981, 1982). However, the dialectic might best be summed up by Marx writing in *Grundrisse* (1973), when he argues that

> It must be kept in mind that the new forces of production and relations of production do not develop out of *nothing*, nor drop from the sky, nor from the womb of the self-positing Idea; but from within and in antithesis to the existing development of production and the inherited, traditional relations of property.
>
> (1973, p. 278)

These recently translated writings, plus the scholarship of people like Rosenberg and Giddens, clearly indicate that Marx was not the technological determinist that he has occasionally been presented (see Burns 1969, ch.3). Rather, his dialectical method emphasised 'the mutual interactions and feedbacks between economy and technology' (Rosenberg 1983, p. 36).

The thrust of technological change is related to 'the contractual encounter between capital and wage-labour' (Giddens 1982, p. 42). Thus technology itself mediates the relationship between capital and labour. Consequently the historical and social outcome of technological change reflects the dialectical interaction between the forces and the relations of production. With this interaction in mind O'Connor (1984) also argues for a dialectic perspective of technological change where it is recognised that broader social perspectives both condition and are conditioned by any changes in technology. Nevertheless, he argues that

> the existing social relations of production may exert a decisive influence on the particular direction of technological change. Given alternative technological possibilities which are comparable in terms of their impact on economic efficiency, one or another may be preferred by those in a position to make decisions regarding the choice of technique depending on the dominant social relations of production in a particular society.
>
> (O'Connor 1984, p. 5)

Weber also was critical of a deterministic view which saw technological developments resulting from the quest for more efficient productivity and necessarily leading to the benefit and good of society. In similar fashion to Marx, Weber stressed that technological innovations should be seen in their historical and social context. Thus he argued that

> it was and is certain *historically* given and historically alterable *social* conditions, i.e., constellations of *interests* of specific kinds, which made first possible and will make possible (or even impossible) the utilization of *technical* 'discoveries' in general, and that consequently the way in which the future of technological development takes shape is also dependent upon the development of these constellations of interests and no way upon purely technical 'possibilities' alone . . .
>
> (Weber 1984 (original 1909), p. 51)

Thus for Weber technology develops from the interaction of various interest groups who are located in a particular historical and social milieu. Weber considered that technology was a dependent variable. Technological innovations such as those in textile factories are worthless without large consumer markets and the ability to produce large amounts of wool and cotton. Indeed technological inventions themselves are a consequence of a perceived 'need' which is located in a particular social relation. Moreover, the actual implementation of technology can be seen to enhance capital's profit at the cost of labour. Technology in this way is used to tip the balance of social relations in the workplace in favour of capital. Consequently 'The tendency toward rationalizing technology and economic relations with a view to reducing prices in relation to costs, generated in the 17th century a feverish pursuit of invention' (Weber 1961 (original 1923), p. 311). Costs could be reduced through either enhanced prediction and control of production or reduction of wages. Following on from Weber, neo-Weberians such as Collins discuss technological changes in terms of 'weapons' which are used by both capital and labour in a struggle for dominance. Technology should therefore be examined in the light of the interests and resources of those who implement it and the action/reaction of those on whom it impinges (see Collins 1975).

If a dialectical view of technological change is accepted then it should be clear that technological change is not autonomous and value free, but is rather the result of a chain of options which both conditions and is conditioned by the bonds which constitute our social fabric. In this way technology reflects the social structure from which it originates. Technology is neither ideologically neutral nor has it been introduced in a neutral or random fashion.

A dialectical perspective also means that we should not view technology as having a form and rationality of its own. It is a misconception to create a vision of technology which is separate and divorced from its social context. It has been argued earlier that technology did not suddenly arrive out of nothing. The way in which technology is designed, developed and utilised is a reflection of the intellectual and creative energy of human beings. Technological development can take many directions and forms. In fact, technology can only be properly understood by placing it in its human context and questioning the present and potential forms of technological innovation. For technological innovation itself is not an inviolate determinant. Indeed, quite the opposite is the case, for as Perrow (1983, p. 521) explains when discussing the structure of social relations in organisation, 'Rather than technology determining organizational structure, it would appear that machines and equipment are designed so that they reinforce existing structures and reproduce these structures in new settings'.

If this is the case, then it is unlikely that technology has been introduced in a neutral or random fashion. It embodies neither of these qualities, because by reproducing the unequal structure of society and institutions it also reproduces the dominant ideological position which justifies and gives support to the unequal distribution of power and rewards. Consequently technology can always be seen as beneficial to some and detrimental to others. Who benefits and who is disadvantaged reflects in turn the conscious decisions of those in power, which give rise to the particular time and extent of technological innovation. This critical stance reflects the position which the followers of Ludd accepted. Although their approach toward technology has been distorted and vilified some balance has been restored by the recent work of Winner (1977), Berg (1979), Robins & Webster (1983) and, of course, the English historian E. P. Thompson.

Luddism

Closely associated with the vision of an ongoing march of technological development is the dismissal of those who oppose new technological innovations as Luddites and neo-Luddites. The term 'Luddite' refers to the followers of Ned Ludd who opposed the way technology was introduced into Yorkshire in the early nineteenth century. But the term still carries great force. Recently the Australian Postal and Telecommunications Union was accused of 'postal union ludditism' for its opposition to new technology which would throw out of work many of its membership (*Sun-Herald*, 9 June 1985, p. 41). Similarly even writers who are generally wary of a deterministic approach talk disparagingly of adopting a 'Luddite mentality' (Mere 1984, p. 47) or a 'neo-Luddite abhorrence' (Ellyard 1984, p. 84) toward the introduction of new technology. For many writers any opposition to technology is mindless, and mindless opposition is a convenient label which has been identified with the activities of the Luddites. In this vein the writers of the Williams Report (Committee of Inquiry into Education and Training 1979) and the Myers Report (Committee of Inquiry into Technological Change in Australia 1980) were quick to dismiss any so-called Luddite concerns in arguing for the continuing application of technology with its envisioned, taken-for-granted benefits to society and workers in general. But Ford (1984) has pointed out that such optimism associated with the introduction of new technology has not been vindicated by studies conducted in Australia at the plant level. He points out that such studies have

> found little evidence that technology had improved the quality of working life. In fact, those studies highlighted the appalling work conditions in many old and new industries. Similarly, the priority for the introduction of new technologies into offices in recent years has had little to do with improving the quality of working life. In fact, the reverse is true. Tenosynovitis has reached almost plague proportions in some offices because of the failure to develop appropriate new working arrangements with the introduction of new technology.
>
> (Ford 1984, p. 157)

In the light of such research findings it is not surprising that unions such as the Australian Postal and Telecommunications Union should be wary of the ideological structures built into the new technology and the likely outcomes on the unionists' lives which would follow its introduction. Similarly, as Berg (1979, p. 43) indicates, the followers of Ned Ludd were not against technology *per se*, but against the breaking of apprenticeship rules and wage agreements, and employer hostility to their unions. The Luddites were not against technology but they were against the way particular technologies were developed and used in an attempt to break any power and control the worker may have had.

The Luddites, as historians such as E. P. Thompson (1968) have shown, were not irrational zealots blindly lashing out at the inevitability of technological change. Rather Thompson has viewed the response of the Luddites as an attempt to put forward a working-class alternative to the political economy of the newly emerging business class. Thus 'the men who attacked Cartwright's mill at Rawfolds were announcing this alternative political economy, albeit in a confused midnight encounter' (Thompson 1968, p. 604).

The actions of the followers of Ludd sought, through their alternative, to put forward morality in place of *laissez-faire* and social priorities in place of control and profit. In this way they foreshadowed the efforts of those such as Mike Cooley at Lucas Aerospace, discussed later, to employ technology in more socially useful ways. Robins & Webster sum up the activities of the Luddites in the following way:

> Luddism was a force that, if it looked back to better times in demanding 'full fashioned work at the old fashion'd price established by Custom and Law,' also looked toward the future of working-class organizations and aspirations. It does not deserve the sneering dismissal it so frequently receives today. By most accounts this is not what it received from contemporaries; in spite of a large presence of troops, government spies, and rewards for informers, the detection rate for Luddite activists was remarkably small. The only satisfactory explanation is that Luddism enjoyed popular, if tacit, support.
>
> (Robins & Webster 1983, pp. 194–5)

An examination of the historical evidence does not support the glib, distorted view of the Luddites which easily flows off the tongues of those debunking any opposition to a certain direction of technological change. The result is that many potential critics of the way technology is used are wary of confronting its implementation. In this way critique is deflected and contained within an ideology of inherent technological advance and progress. Consequently 'In confronting the introduction of new technologies—already constituted as expressions of capital and *its* needs—it is necessary for us to adopt the ethical stance of critique, the stance that looks to a social reality other than that determined by capital' (Robins & Webster 1983, p. 206; see also Cooley 1980a and 1980b, and Thompson 1976). This was the critical stance of the original Luddites. When critically examining any new innovation in the textile trade they applied two basic, critical criteria. First, does the new device enhance the quality of the product being manufactured? Second, does the machine improve the quality of work? If the answer to one or both of the questions was 'no' they took action to try and block the implementation of the new technology (see Winner 1977). In this way technology reflects an historical, social process through which practices are continually being constrained and enhanced through the ongoing transformation of social structures. In this dialectic human agents are acting on the outside world and transforming it, while simultaneously the nature of the human agents is also being transformed, enhanced or constrained through this interaction. Thus 'this historical enterprise always contains a range of possibilities as well as necessities, possibilities seized upon by particular people, for particular purposes, according to particular conceptions of social destiny' (Noble 1979, p. xxii). But, as we will see in the next section, Kondratieff argues that historically, technological change seems to come in distinct episodes or waves seemingly devoid of a sense of this range of possibilities. This lack of possibilities has led Mensch (1979) to argue that Kondratieff's theory is basically deterministic.

Technological cycles

Some historians studying technological change have discerned that change appears to come in waves or cycles. The work of Kondratieff and his followers would lead us to believe that we are entering a fifth wave of technological change. Jones (1982), however, describes the sequence of change in terms of three revolutions.

Nikolai Kondratieff, a Russian agricultural economist, in the 1920s published a paper which put forward the proposition that there were distinct eposides in economic history (see van Duijn 1983). These episodes constituted waves or cycles of economic development. These cycles were perceived to occupy a period of fifty years which comprised first growth and then decline. The first wave, between 1789 and 1849, was in a period of growth until 1834 but then declined until 1849. The second wave was between 1849 and 1896. It grew until 1873 after which it declined. The third wave was in an upswing between 1896 and 1920 (see Figure 1). However, by projecting the period after Kondratieff's paper, Jones (1983) puts forward the years 1920 until 1945 as years of decline. A similar projection indicates a period of growth between 1945 and 1970, after which there would be a time of decline extending into the 1990s. The troughs in the waves seem to correspond to the depressions of the 1840s, the late 1890s and the 1930s, and the severe recession of the 1970s.

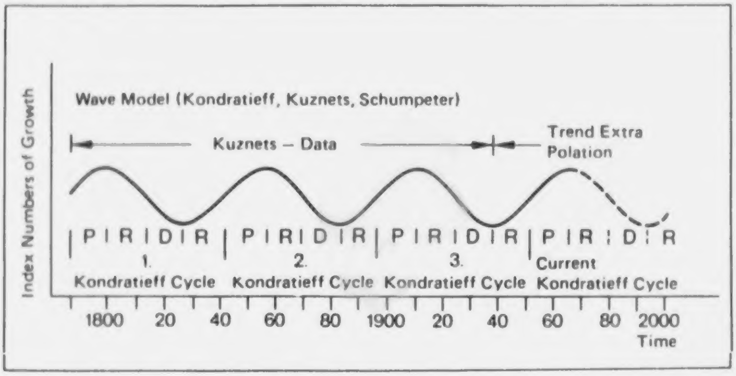
Kondratieff postulated that these waves had certain empirical characteristics. Thus:

> 1. During the rise of the long waves, years of prosperity are more numerous, whereas during the downswing years of depression predominate.
> 2. During the downswing, agriculture usually suffers an especially pronounced and long depression.
> 3. During the downswing, many important inventions in the techniques of production and communication are made; however, these are usually applied on a large scale only at the beginning of the next long upswing.
> 4. At the beginning of a long upswing, gold production usually increases, and the world market is enlarged by the assimilation of new countries, especially the former colonies.
> 5. It is during the period of the rise of the long wave that the most disastrous and extensive wars and revolutions mostly occur.
>
> (Kondratieff, in van Duijn 1983, p. 66)

Importantly, however, Kondratieff claims that the cycles are also associated with the development of new forms of technology. The first wave can be linked to the development of the steam engine. The second wave can be associated with the expanding railway system, while the third wave might be related to the growth of the chemical and electrical industries. Kondratieff believed that while these important technological advances took place initially during the period of decline in the wave, the fully developed technology

> usually applied on a large scale only at the beginning of the next long upswing . . . It is during the period of the rise of the long waves, i.e. during the period of high tension in the expansion of economic forces, that, as a rule, the most disastrous and extensive wars and revolutions take place.
>
> (in Jones 1983, p. 15)

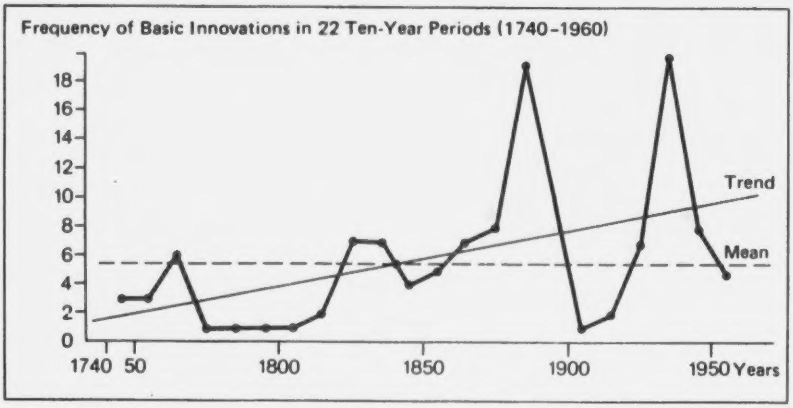
Figure 1: The Kondratieff wave model



Source: Adapted from Mensch (1979, p. 73).

Note: The main phases of the wave are prosperity (P), recession (R), depression (D), and recovery (R).

Figure 2: Swells of basic innovations



Source: Mensch (1979, p. 130).

The location of technological innovation at particular periods within fifty-year long waves have given rise to the identification of particular swarms or bunches of historically contemporary high tech (see Figure 2). An explanation of this suggests that, as old technologies become obsolete and depreciate at the trough of the wave, new opportunities arise for capital creation through radical new technologies (see Sterman 1985).

In the light of these studies a fifth wave has been suggested by Emery (1978). The technological advances being set in place during the current downturn of the fourth wave will be the trigger for the next wave. Emery sees that the escalation of high tech, including microelectronics, will push the economy out of the deep recession and into a fifth wave.

However, Kondratieff's conception of long waves has not been widely accepted, particularly in Anglo–Western countries, even though Keynesian economics is also founded on long-term economic cycles. This has been partly due to the difficulty of proving the existence of a fifty-year cycle, and partly due to the length of the period of post-war economic growth in those countries. But the Dutch have always been interested in Kondratieff (van Duijn 1983) and, to a lesser extent, other European economists (Mandel 1980). Mensch (1979), however, has labelled the Kondratieff cycles as deterministic. He argues that the idea of historical determinism precludes human agency while incorporating a deterministic recurrence of the various phases of the wave.

Jones (1983) also is not completely convinced of the correspondence between Kondratieff's long waves and the historical sequence of technological change. Jones sees the present period, instead, as the third of a series of technological revolutions (see also Windschuttle 1979).

Jones agrees with Kondratieff that the first revolution was based on the steam engine when the power of steam was applied to the production of textiles, to manufacturing, mining and transport, consequently 'Where one man had operated a single spindle in 1770, by 1840 his grandchild could operate one hundred' (Jones 1983, p. 12).

The second revolution in technological development, according to Jones, was from approximately 1860 through until 1910. This revolution came about with the generalised application of electricity and the internal combustion engine. As Jones points out:

> It was based on applied technology, marked by huge increases in the production of steel and chemicals, the use of oil and electricity as an energy source for industry and transport, the electrification of cities, the telephone and telegraph, cheap photography, scientific medicine, the first plastics, motor cars, aeroplanes and radios.
>
> (Jones 1983, p. 12)

The 'Atomic Revolution' is the way Jones describes the third technological revolution. It was triggered in 1942 by the harnessing of the nuclear chain reaction and the consequent introduction of nuclear fuels for military purposes and to generate energy. However, this revolution is also marked by the application of electronics not only to control and regulate machines but also to store vast amounts of knowledge. Jones contends that, in this revolution,

> Its sustaining theme has been the development of pure and applied research towards the exploration of extremities, and its major achievements include atomic fission and fusion to produce explosive quantities of energy, supersonic aircraft and missiles, radio astronomy, the investigation of outer space, planets and the moon, explaining the complexities of DNA and protein structure, computers, micro-electronics and the universal diffusion of synthetic materials, television, civil aviation and the motor car.
>
> (Jones 1983, p. 13)

However, the third revolution would seem to differ from the others in the almost breathtaking speed which exists between invention, innovation and implementation. Especially in the area of the four major high tech areas (photovoltaics, biogenetics, robotics and microelectronics) the pace of technological change is such that ordinary people have difficulty keeping up with the changes, let alone understanding them. Thus we see black vinyl records being replaced by compact discs which are recorded digitally by a computer and played back by a laser beam. Banking is now carried out by computerised banks, with plastic cards replacing money as a means of exchange. There is now electronic fuel injection in cars, coupled with digital readouts relaying the most detailed information from a car's dashboard. In the home there are the computers, videos and microwave ovens which are virtually out of date before they are bought. The continual application of technology to everyday consumer commodities gives the impression of a very rapid rate of technological change. Reinecke (1983) has reminded us that the first electronic computers of the 1940s evolved only in response to the demands of the Second World War. The best known were Harvard, Eniac and Colossus. He points out that

> Eniac . . . was used for a variety of tasks, from checking inventories for the navy to breaking communication codes. Colossus, the British version, is credited with cracking the communication code used by the Axis countries. All had one thing in common—their enormous size. Eniac, for example, was more than 15 metres long and 7 metres high. Colossus and Eniac both used valves.
>
> (Reinecke 1983, p. 32)

Not only were these computers dependent on valves but they also used vast amounts of electricity. When IBM switched from valves to transistors its electricity bill was cut by 95%. However, in a relatively short time these artefacts have become relics of the past. With the development of the chip and microelectronics much more reliable and complex computers, costing only a few hundred dollars, can be carried in a briefcase and operated on a work site. Also, importantly, these computers have been made 'user-friendly', which means little skill or training is needed to operate them. Indeed, the fact that computer users can operate computers without a knowledge of programming languages and without the mediation of computer experts may have severe effects on jobs in the computer industry.

The centre of this recent high tech is Silicon Valley in California, USA. It is important not only for its dominance of the industry but also because many people hope to copy its growth. By doing this successfully the present ill winds of economic misfortune might be negated and a new era of prosperity generated. Therefore, because of its obvious importance, Silicon Valley will be examined in more detail in the next section.

The Silicon Valley model

Silicon Valley is the name conjured up to describe the hundreds of low-slung, noiseless, smokeless, gleaming factories that sit between Freeway 101 and El Camino Real, the two main routes through this area of California. The factories found in the area are those like Zilog and Intel who are semiconductor companies concerned with putting information on to the small silicon chip, and like Apple and Hewlett-Packard who use the chips to manufacture the computer hardware. Also there are the satellite software companies designing the software which provides the computer with its program of action.

Silicon Valley epitomises the traditional concept of classical capitalist development combining high elements of risk and uncertainty with venture capital, mediated by large slabs of luck. It was largely founded on the work of William Shockley who, with the backing of millions of government dollars, invented the transistor in the late 1940s. Moving near Stanford University, whose presence had fostered a number of electronics companies, Shockley worked for one of these at Palo Alto in the Santa Clara Valley. Here also a design team led by Ted Hoff invented the microprocessor, a semiconductor chip containing thousands of integrated circuits as well as a memory (see Reinecke 1983). The coincidences of Shockley going home to a location near Stanford, which had creative graduates like Hoff looking for jobs, quickly transformed the Santa Clara County area. As Howard describes it:

> Thirty years ago, Santa Clara County was known mainly for its fruit orchards and the silicon chip did not exist. Today the county is blanketed with some 500 electronics firms ranging in size from 16,000 workers to 10 or less, and Silicon Valley has become the center of a $100 billion world electronics industry producing everything from calculators to cruise missiles, Space Invaders computer games to industrial robots.
>
> (Howard 1981, p. 22)

In the present era of economic downturn, of unemployment and plant closure, of de-industrialisation, Silicon Valley stands out as the symbol and the future path that it is thought industry must tread if new jobs are going to be generated and new wealth accumulated. Consequently the popular press in Australia and overseas proclaim that industries must look towards new high tech in order to generate new wealth and jobs. Moreover, they conclude that there are signs of a new consensus that Australia must embrace technology if its existing industries are to survive and if new industries are to flourish (Roberts 1984).

The development of a high tech industry seems to many national and local governments to depend on the creation of new 'Silicon Valleys'. In this vein the Australian government has encouraged the Australian Industry Development Corporation (AIDC) to become actively involved in the development of high technology industries. One aspect of this involvement has been the investment of $70 million in the AIDC's industrial research investment scheme. Paralleling this federal activity has been the involvement of a number of state governments, through the establishment of technology parks in Adelaide and Perth and a centre for technology and design in Melbourne (Roberts 1984). Such developments are an attempt to emulate the Silicon Valley model, where high tech parks have arisen specialising in semiconductors, computers, telecommunications, robotics and biotechnology, near major universities such as Stanford.

The rush to set up these technology parks is not only confined to Australia but also is a major concern of local and state governments in England and America. For example, Chicago and San Antonio have put forward plans to set up programs to foster the growth of high tech. Both cities aim to promote industries concerned with electronics, biotechnology and robotics. This promotion will be facilitated by the creation of investment funds and by redirecting education towards the needs of the new industry. This promotion will also involve locating the parks near universities not only for research interaction but also to attract federal research funds. Grubb (1984) illustrates that educational reform is seen as attracting much of the new high tech industry. In this way

> the robotics program at Oakland Community College (Michigan) has been justified as contributing to 'Michigan's salvation' by replacing jobs lost in the auto industry, and the president of a community college in an area of high unemployment has declared that 'the development of high technology programs represent[s] our very best hope, not only of attracting new industry to our area, but for helping existing industry compete and prosper.'
> (Grubb 1984, p. 432)

These communities hope that by creating a favourable economic and educational climate they will be able to compete from a position of advantage in attracting high tech corporations. By creating a supply of suitable workers it is hoped that a demand for their services will eventuate.

However, scholars such as Macdonald (1983) have grave doubts on whether the success story of Silicon Valley can be transferred to a comparable site in Australia. Macdonald argues that it is a mistaken assumption to conclude that almost anywhere that can offer a pleasant climate, universities and large amounts of high risk capital can become another Silicon Valley. As a consequence, he argues, 'high technology policy is easily confused with employment, education and, particularly, regional development policy' (Macdonald 1983, p. 335). Moreover, it is not so much an elite of high tech engineers that is the dynamic force in Silicon Valley but low tech service professionals. As he puts it, 'the major participants in the innovative process are such people as accountants, managers and salesmen—not high-status scientists and engineers' (Macdonald 1983, p. 336). The main concern in any capitalist enterprise is marketing and selling the commodity. The historical context of Shockley deciding to settle in Palo Alto and the consequent offsprings, such as Fairchild Semiconductor, combined with the high mobility of the people in the industry, make it almost impossible to emulate Silicon Valley. Macdonald concludes that by putting into place the commonly accepted criteria on which it is thought that the Silicon Valley model is based 'there is only the prospect of chaos, waste and ultimate disappointment' (Macdonald 1983, p. 344).

All of the success of Silicon Valley has not been spread evenly. While there has been much wealth generated with the instant millionaires, such as Stephen Wozniak and Steven Jobs of Apple, not all high tech industries operate completely with high tech occupations (see Watkins 1985). Much of the work is repetitive assembly line work. In Silicon Valley this work is performed largely by women and minorities, made up increasingly of Hispanics and Filipino and Vietnamese immigrants. Even these workers are likely to command a wage which is considered too high by the corporate managers. Consequently many of the companies have branches in Asia situated near airports where jumbo jets can shuttle the chips easily across the Pacific Ocean. These new assembly line workers are in Malaysia, the Philippines, Indonesia and Hong Kong. They are typically women who in 1981, according to the *National Times* (February 1981), were paid about 10 cents a day on the eye-straining work of wiring the chips to the minute circuit boards.

This ability of high tech to facilitate the transfer of jobs and production may mean that not just parts of the manufacturing process but indeed almost the entire company may be moved to an overseas location. Levin & Rumberger (1983a), for instance, report that Atari was, at that time, considering shifting most of its production facilities to sites in Taiwan and Hong Kong. The immediate result is to be that 1,700 workers in its Silicon Valley facilities will be sacked. In a transfer of this scale the impact of redundancy not only hits the production workers but also middle management.

Such activity suggests that all is not completely well in Silicon Valley. It appears that the optimistic growth which others hoped to emulate has not been sustained. In fact the semiconductor industry has been described as being in mid-life crisis (*Electronics Week*, 17 May 1985). From August 1984 until June 1985 18,000 jobs were lost in Silicon Valley. Both Apple Computers and Wang Computers sacked 1,600 employees, and more than 5,000 jobs were lost overall in June 1985 alone (*Business Week*, 24 June 1985; *Australian*, 29–30 June 1985). Austerity programs are being introduced into most companies; for example, Advanced Micro Services is making its employees work longer hours for no extra pay. In addition, there are plans to put the majority of its 8,000 workforce on to a four-day week with a 15 per cent cut in pay, after closing the plant for a two-week period (*Australian*, 29–30 June 1985). The cause of the crisis has been the almost total collapse of interest in the home computer and video game markets. The boom in consumer high tech, for the moment at least, seems to have burst. Consequently personal computers and video games are being dubbed the 'hula hoops of the '80s' (*Australian*, 29–30 June 1985). The loss of interest seems to have come about because people are re-evaluating whether, in fact, computers do provide information more efficiently, more easily and more productively. For example, is it easier to have cooking recipes displayed on a video screen or on cards which can be moved and placed next to the cooking utensils? The extent of the crisis in Silicon Valley should make those who blindly set out to follow Silicon Valley's pattern rethink their approach to high tech.

Howard (1981) points out that many of the high tech industries actually work on the same basis as the mass-production, assembly-line techniques of the car industry. Basically there are three stages to the assembly-line process. First, workers look after process machinery producing the quartz (silicon) and testing the integrated circuits. Next the circuits have fine wires attached under high-powered microscopes. Last, different circuits are 'stuffed' into printed circuit boards.

To provide some idea of the work done by these high tech assembly-line workers Howard presents a vignette of one of them:

> Susan Hofffman has worked in printed circuit board assembly at firms across the Valley. She has stuffed boards in 'clean rooms' where the environment is closely controlled for dust and workers wear rubber gloves, caps and smocks known as 'rabbit suits.' She has also stuffed them in a garage where during the summer the temperature hovered around 100 degrees. Either way, she says, stuffing 80 to 100 PC boards all day is 'dehumanizing work.' First, the worker places the circuits in the board, then passes it through a wave solder machine to fix the connections, then cleans it in an open tank of freon, a common industrial solvent. At the smaller companies, says Hoffman, the soldering is done by hand, the fumes from the burning metal are strong, but you can usually get a small fan if you ask for it.
>
> (Howard 1981, p. 23)

The fact that many of the jobs in the high tech companies of Silicon Valley are repetitive, routine assembly-line jobs has accentuated a distinct labour market segmentation (see Rogers & Larsen 1984). The theory of labour market segmentation claims that there exists in the labour market distinct primary and secondary segments. The primary sector in Silicon Valley comprises the elite technicians, managers and sales personnel. In the secondary sector are the women and minorities for whom high tech industry 'means low-wage, dead-end jobs, unskilled, tedious work, and exposure to some of the most dangerous occupational health hazards in all of American industry' (Howard 1981, p. 22). The existence of these two labour markets in high tech and the realisation that high tech does not necessarily mean high tech occupations are matters which should be of great concern to educationalists. This concern should especially manifest itself when reflecting on the calls to link education, instrumentally, to a high tech future.

The gender implications of technological change

In the previous section an examination of the Silicon Valley example of high tech highlighted the presence of a segmented labour market. There were two distinct segments: a primary sector occupied by the high tech creators, accountants and managers, and a secondary labour market occupied mainly by women and minorities who do repetitive, assembly-line, often part-time casual work. The Kirby Report (Committee of Inquiry into Labour Market Programs 1985) also perceived a similar general situation in Australia. It found that 'The incidence of part-time employment was particularly high among women . . . [Also] Some 17 per cent of female employment was in casual jobs, a far higher proportion than for any other group' (Kirby Report 1985, p. 43).

As well, the findings in the Kirby Report again supported the evidence from the Silicon Valley example that the labour market is frequently divided on the grounds of gender. As the Kirby Report puts it:

> Underlying these patterns of inequitable access to employment is a high degree of labour market segregation on the basis of gender . . . Female employment is concentrated in relatively few major occupations and industry categories. For instance, in August 1984 over 33 per cent of women in the workforce were employed in clerical occupations, many of them in low skilled jobs, compared with 8 per cent of males. In August 1984 over half of female employment was concentrated in the community service, wholesale and retail trade industries, with low skilled, low paid jobs . . . Gender segregation in the labour market is an important reason why, despite the existence of the 'equal pay' principle, female earnings remain low relative to those of males.
> (Kirby Report 1985, pp. 43–4)

As Apple (1985) suggests when looking at similar figures in the United States of America, these statistics would seem to indicate that the work women have traditionally done is related to both a vertical segmentation where women are disadvantaged compared with men and also a horizontal segmentation where women are concentrated into specific types of work.

Kramar (1984), when studying the employment of women in the New South Wales Public Service, has bluntly stated that divisions within the service are based on sex. 'The sexual division of labour is hierarchical, with men dominating senior authority positions, while women are concentrated in temporary, subordinate and routine jobs' (Kramar 1984, p. 200). The research by O'Donnell (1984) in Australia also supports the thesis that women have been disadvantaged through the sexual division of labour. Not only is the average female wage only about 67 per cent of the average wage for a male worker but the position of women in the labour market is likely to be much more insecure than that of men, while still occupying the lowest rung of the occupational hierarchy (O'Donnell 1984, p. 147). Even if it were remembered that the higher number of teenage females working accentuates this disparity in the average wage, the point about the differences between male and female wages remains valid. With the introduction of high tech the division of labour based on gender has not been alleviated. Rather it has been exacerbated. Baldock, for instance, has found that 'the result of the introduction of new technology . . . is more likely than not an artificial reclassification of labour, and a further strengthening of the gender division of labour' (Baldock 1984, p. 276). Following the concern of these scholars this section will examine the impact of high tech on those areas of work in which women are predominantly found. In particular this action will look at the impact of high tech on office work and general 'white-collar' areas of employment.

One of the major areas where computers and new information technologies are having the greatest impact is on the working conditions of women. For instance, 'Bank work has become increasingly routinised and repetitive', while the deskilling process 'in white collar work such as banking . . . refers to a loss of knowledge of banking processes as a result of fragmentation' (Game & Pringle 1983, p. 56; see also Garson 1981). In particular, the increasing automation can be used not only to reduce secretarial skills in occupations which are predominantly female but also to centralise the work. For example, word processing tends to be located in central work stations involving routine, repetitive, keyboard-based data entry tasks which are fragmented and remote from the decision-making sources of the organisation (see Downing 1983).

The main thrust in the implementation of high tech in the office is to reduce the production costs per worker by automating the flow of work. The office worker is seen as not very productive compared to the blue-collar worker in the factory. Windschuttle (1983) has pointed out that, in the United States of America,

> about 84 per cent of the office costs are labour costs and, in the last decade, American office productivity has risen only 4 per cent compared to industrial productivity's 90 per cent. Capital expenditure per worker in American industry is $25,000; in offices only $2,000. The most realistic predictions do not suggest that offices will match the efficiency of the factory, but there is still plenty of ground to be gained.
>
> (Windschuttle 1983, pp. 81–2)

In an attempt to match the factory, office work is being broken down into smaller fragments while individual knowledge is being extracted and deposited on computer programs. In this vein Robert Noyce, vice-chairman of Intel, has commented that

> We still have an enormous amount of paper in our society. If you look around the office, there is hardly a piece of paper that couldn't be eliminated with adequate file systems and retrieval systems—all of which will take more and more intelligence from the computer on the desk . . . We are just at the beginning of mechanising all of this intellectual activity going on—which represents by far the greatest portion of the work force.
>
> (*National Times*, 1–7 February 1981, p. 20)

Charles Sporck, of National Semiconductor, added: 'This technology can replace much of the manual labour now in use, and increasingly more of the skilled labour' (*National Times*, 1–7 February 1981, p. 20).

The transfer of much the workplace intellectual activity to management through the computer process makes office employees easier to control and also easier to replace. Cooley (1980a) has argued that the introduction of high tech into traditional white-collar areas of work will mean a decline in the quality of work to the office worker, just as it has already done to the factory floor. He suggests that 'there are now good grounds for believing that we are beginning to repeat in the field of white-collar, intellectual and conceptual work, most of the mistakes we have already made at enormous cost at earlier historical stages when skilled manual work was subjected to technological change' (1980a, p. 524). Cooley concludes that high tech might be regarded as a 'Trojan Horse' to dehumanise and fragment work into minute repetitive tasks, each accurately timed (see also Watkins 1986a).

As Feldberg & Glenn (1983) show, because of the segmentation of the labour market and its relationship to family gender hierarchies (Feldberg & Glenn 1979), the impact of technology in the office may differ for men and women. Examining the impact of new technology on occupational structure they reached a number of conclusions. They found that the new office technology was labour saving, reducing the number of people required in some jobs. Second, although there was a slight increase in the labour force, the number of traditional clerical jobs was reduced. Third, the introduction of the new technology was also used to reorganise the work. Occupations became narrower, more specialised, and standardised, thus becoming independent of a worker's experience and knowledge. Fourth, the introduction of this high tech has increased the need for more highly paid new positions. However, these are most likely to be a male preserve, with women most unlikely to move into these jobs. Thus Feldberg & Glenn found that 'with increasing automation, male/female stratification in the office became even more pronounced' (1983, p. 69). However, it would perhaps be wrong to see this as the result of an overt conspiracy on the part of men to degrade women. Rather it can be seen as reflecting the commonly held, taken-for-granted assumptions which underpin perceptions of femininity and masculinity. It could be argued that many of these new positions are believed to require aggressiveness, ruthlessness and the ability to make tough decisions. However, such traits are ideologically linked to masculinity rather than to femininity, leading to 'natural' segregation in the workforce. (See Baker 1964; Watkins 1986b.)

Such conclusions on the effects of high tech on women in the workforce is supported by a number of authors (Downing 1980, 1983; Buchanan & Boddy 1982; Arnold, Birke & Faulkner 1981; and Morgall 1983). Morgall points out that word processors in offices can be used both as a means of greater managerial control and to further widen the gap between what is seen as 'men's' and 'women's' work through the downgrading of skilled women workers. Similarly, Buchanan & Boddy (1982) found in their research that the skill levels of the women working in offices were reduced by the introduction of word processors. Work was created which was essentially specialised, repetitious, routine and boring, with a reduction of the knowledge and understanding of the end product. Both Morgall and Buchanan & Boddy argue that these situations were the result of managerial decisions. They were not the result of the deterministic, inexorable march of technology. The word processors could have been used in alternative ways. The technology could have been used to increase the intellectual involvement and skill requirements of the women operating the word processors. However, management's preoccupation with better control techniques took precedence over any other considerations (see Buchanan & Boddy 1982, p. 10). As Arnold, Birke & Faulkner (1983) conclude, with the emphasis on control 'the patriarchal hierarchy, in which women are subordinate to men, is only likely to be reinforced and intensified by the advent of word processing technology' (Arnold, Birke & Faulkner 1983, p. 336). To correct this reinforcement of the patriarchal hierarchy Baldock (1984) proposes that technology should be reformulated on a more caring, concrete and personalised basis. There would be a recognition that women do not lose their skills through new high tech. Rather, the skills of women are undervalued and are excluded, through the application of the new technology (Baldock 1984).

While Feldberg & Glenn (1983) and Arnold, Birke & Faulkner (1983), for example, point out that the contradictory nature of the technological innovations, as well as the depressed economic scenario, have made any resistance to the way technology has been used muted and defensive, management is not necessarily seen as omnipotent. Downing (1983) in her research into female work in banking has highlighted some ways in which women contest these new techniques of managerial control.

Downing (1983) reports that the introduction of new high tech by a major US bank into its San Francisco branch was expected by the women workers to increase their intellectual involvement and their autonomy. However, these expectations were not realised. Rather, work was reorganised on an assembly-line basis with increased monitoring and control. As one word processor operator indicated to Downing:

> Everybody was excited to learn this new thing that was going to help alleviate boredom and make life easier, and then they found out that they didn't do that at all—in fact they made it more boring. People felt that they were plugged into machines, that they were appendages to machines rather than people performing functions with other people.
>
> (Downing 1983, p. 47)

The way the new technology has been employed and the consequent organisation of work led the women to develop ways of using the technology to give vent to their dissatisfaction. So that they could break the repetition, they discovered and utilised the code for bringing the system down for maintenance. To counter the strict time deadlines the women used strong magnets to erase the computer tapes 'by accident'. When the preoccupation with strict control became too much the 110 word processor operators would all rise at the same time to go to the toilet. Finally, Downing found that when things became extremely bad the women 'would "forget" to key in their personal reference code which was necessary for their productivity count, and would proceed to key in obscenities which would come out on the printout' (Downing 1983, p. 50). Because the work had been routinised and standardised it was impossible to discover where to lay the blame. The consequence was that management was forced to reevaluate the accepted IBM approach to the word processor centre and to 'rethink' their philosophy on high tech and the organisation of the word processor operators.

In this section we have looked at the development of high tech and its application in the workplace. In particular we have looked at the way new technology has had an impact on white-collar office work which has traditionally been largely the domain of women workers. In the next section the likely consequences and implications of these trends on education will be examined.

The influence of high tech on education

This section will firstly look at the influence high tech will have on future job opportunities. Secondly, the educational response to these projected patterns will be discussed.

High tech/low tech jobs

The increasing dominance of high tech in the lives of ordinary people has provided the hope of a new avenue along which the education of children might proceed. The production and servicing of these new advanced technologies is assumed to require a much more highly credentialled and qualified workforce. Pogrow (1983), for instance, puts the case that schools must produce more individuals skilled in high tech to meet the demands of the job market. This would include producing both students with high levels in maths and science skills to advance the frontiers of high tech and a plentiful supply of teachers to impart these skills. Education, Pogrow argues, must increase the number of individuals, scientists and engineers to satisfy the needs of the future high tech job market. In Australia a similar functionalist relationship between high tech and education is often presented. 'More than ever before education must seek to develop and enhance the talents of each individual and yet at the same time encourage that individual to contribute to a cohesive society based on understanding and respect' (Stranks 1983, p. 143). Stranks sees the problem, essentially, as one of organising the natural resources of human capital on a more efficient basis to cope with the demands of high tech. Citing the Williams Report, the Myers Report and the Keeves Report, Stranks claims that there is overall agreement that education 'must respond in ways that will enable us to manage and adapt technological change to our advantage' (1983 p. 143). A solution is offered by the example of Singapore, with that country's drive to foster increasingly higher levels of competence in mathematics. However, the call to link education instrumentally to the development of high tech is not limited to university professors like Stranks. Senator Susan Ryan has also called for higher levels of educational attainment to cope with the anticipated changes in the workforce. In this vein she has commented that the Commonwealth government believes that, as the hoped-for economic recovery takes place, the jobs which will eventuate for young people will require higher levels of education and training than in the past (*Age*, 19 July 1983, p. 18). Similarly Richard Johnson, the former secretary of the Department of Education and Youth Affairs, has commented on the Task Force on Education and Technology in the following way: 'The Task Force will develop options for policy and program initiatives to assist and encourage the educational system in stimulating, anticipating, shaping and responding to technological change and an increased level of technological innovation in Australia' (Johnson 1984, p. 96).

However, not all educationalists are so confident in tying education to the high tech band-wagon. Sweet (1984) and Burke (1984) in Australia, and Grubb (1984), Rumberger (1984a, 1984b) and Levin (Levin & Rumberger 1983a; 1983b; Rumberger & Levin 1984) have emphasised that high skill, high tech occupations will not be as important in the future as low tech, service jobs. In this vein Sweet argues that in Australia the skilled, attractive jobs for young people have declined sharply. His research indicates that technological innovation has had no positive impact on employment for young people. Rather, technological change can be linked both directly and indirectly to a decline in the opportunities for youth entering skilled occupations. Sweet warns that

> A recognition that technological change will not necessarily increase the demand for skills, that in some areas there has been a substantial deskilling because of the way technology has been introduced and that many past trends reflect supply and government expenditure rather than a technological imperative, carries risks for educational policy makers.
>
> (Sweet 1984, p. 23)

The most obvious risk is that those who see education as being closely tied and instrumental to the demands of the workplace will call for cuts in education spending. However, education must be relocated from this narrow human capital agenda and placed on a more critical reflexive and transformative basis.

The trend towards low tech forms of jobs in Australia has also been noted by Phil Ruthven of IBIS Corporate Services and John Brown, the Minister for Sport and Tourism. Brown has pointed out that the leisure industry is creating about 30,000 jobs a year and with 400,000 people is Australia's biggest industry (*Australian*, 28 July 1984, p. 19). Ruthven indicates that the leisure industry will probably create 730,000 of the 2,500,000 new jobs Australia will need by the turn of the century. Most of these jobs will be of a casual or part-time temporary nature, requiring little training or skill. In the United Kingdom these low tech occupations have been called 'Mickey Mouse' jobs. However, Ruthven argues that any job is better than no job and that this type of work will be the only source of income for many people in Australia in the future (*Australian*, 28 July 1984, p. 19).

In the United States of America a similar trend in work is evident. Rumberger (1984a, 1984b) and Levin (Rumberger & Levin 1984; Levin & Rumberger 1983a, 1983b) in recent papers have pointed out that while indeed high tech industries will be growing rapidly because of their low base the actual numbers of jobs created by high tech will be quite low. Their projections in fact indicate that only 7 per cent of the new employment opportunities created will be associated with high tech. In more general terms, Etzioni & Jargowsky (1984) are also critical of the taken-for-granted orthodoxy that assumes that jobs in the United States economy are rapidly moving into high tech areas such as microelectronics, telecommunications and bioengineering. While the high tech area is undoubtedly expanding, the great bulk of jobs will still be in basic low tech industries. They found that basic jobs will continue to contribute a significant amount to the economy and will be an important sector in an integrated economy made up of both low tech and high tech industries.

The basis of the common orthodoxy rests with a number of misconceptions concerning high tech. Rumberger & Levin (1984) argue that misconception has arisen with regard to high tech and employment in three areas. First, as we have seen from our study of Silicon Valley, high tech industries have been confused with high tech occupations. In fact, less than a quarter of the jobs in high tech industries are high tech jobs (Rumberger & Levin 1984; see also Gordon & Kimball 1985). The majority of jobs are low tech, employing easily replaceable female and migrant labour. The second area of misconception relates to the comparative rates of growth for high tech and low tech industries. Any accelerated growth in the development of high tech industries does not mean a large absolute number of workers. This is due to the fact that, compared with traditional areas of employment such as the manufacture of cars, these new occupations employ much fewer workers. Thirdly, Rumberger & Levin (1984) show that, whereas previous technologies have reduced the physical demands of manual work, the present high tech is being used to take over mental, white-collar areas of work. Thus it seems highly unlikely that the introduction of high tech will result inevitably in an increasing number of jobs in new areas of work. For example, the most recent user-friendly computers have already made redundant many computer programmers' jobs (Watkins 1985). Indeed, an examination of the latest in, for example, personal computers, which through the use of 'windows', 'icons' and 'menus' have virtually eliminated any necessity to know a program language, makes any belief in the need for higher skill levels extremely difficult to hold. This impetus to reduce to a minimum any period of skill training by increasing the 'friendliness' of technology is a major aim of the high tech industry (see Guteri 1984).

The trends in the United States appear to be similar to the likely trends in Australia: an examination of the figures of the US Bureau of Statistics by Levin & Rumberger revealed that, while there would indeed be an increase in high tech occupations, by far the greatest increase would be in the low tech clerical and service occupations. They elaborated that

> This picture is further reinforced by examination of individual high technology job categories. While jobs for computer systems analysts will increase by over 100 percent between 1978 and 1990, only 200,000 new jobs will be created. In contrast there will be over 600,000 jobs for janitors and sextons. In fact, more new jobs for janitors will be created than new jobs in all the five occupations with the highest relative growth rates. Consider another example: about 150,000 new jobs for computer programmers are expected to emerge during this 12 year period, a level of growth vastly outpaced by the 800,000 new jobs expected for fast food workers and kitchen helpers.
> (Levin & Rumberger 1983b, p. 5)

From the studies described in Australia and the United States it is evident that high tech is not going to solve the problem of youth unemployment or lead to large numbers of high tech jobs. Indeed, it is in the service industry where the fastest absolute growth will occur. The jobs most evident will be those such as custodians of buildings, nurses' aides, salespeople, cashiers, waiters or waitresses. None of these fastest growing jobs is related to high tech. In the light of this evidence Rumberger & Levin (1984, p. 22) conclude that '*not only will high tech provide few job* *opportunities in the future economy, but most new jobs will require no postsecondary schooling and will pay wages significantly lower than the average'.*

The educational response

The educational response should not be concerned with a blanket hostility towards technology but should rather introduce into the educative process a critical approach whereby we can reflect and explore the social and cultural ramifications of technology's introduction. Educationalists should prompt the consideration of basic questions regarding how and why certain technologies are being used in a particular way. In this way teachers can assist students to understand the values and structures which underline the technological changes going on around them. The ongoing improvement of society and increased human autonomy is thus integral to a critical educative approach. Fay has highlighted the difference between an 'educative' and 'instrumental' approach when he points out that

> Both the instrumentalist and educative models promise freedom; but in the former it is the freedom that results from knowing how to achieve what one wants, whereas in the latter it is the freedom to be self-determining in the sense of being able to decide for oneself, on the basis of a lucid, critical self-awareness, the manner in which one wishes to live. In the educative model, the practical result of social theory is not the means for greater manipulative power, but rather the self-understanding that allows one's own rational thinking to be the cause of one's actions; i.e. social theory is a means towards increased *autonomy*.
>
> (Fay 1977, p. 207)

Through an educative, critical approach in education about technology and work a better understanding of the development of high tech and the society on which it impinges might be engendered. By engaging in such a practice education might be seen not merely as responding to the needs of the economy but to the needs of people. 'Thus education for the workplace needs to attack a finer division of labour, and it needs to give people the capacity to understand, and resist, the forces that are shaping the skills required of them at work' (Sweet 1984, p. 24). Such an educative process would perhaps involve a close examinination of the rationale and strategy developed by Lucas Aerospace workers. Here the concern relies

> not merely on the fact that a group of workers for the first time are demanding the right to work on socially useful products, but that they are proposing a whole series of new methods of production where workers by hand and brain can really contribute to the design and development of products, and where they can work in a non alienated manner in a labour process which enhances human beings rather than diminishes them.
>
> (Cooley 1980b, p. 79)

For schools, comparable practice would not entail merely teaching such things as computer literacy devoid of any social and historical context, for, as Noble (1984) has argued, to do this merely reinforces the ideological notion of a predetermined technological future. Rather, the teaching of such literacy should be coupled to a critique of the economic, political, social and cultural foundations of society. Reinecke (1983) presents the case that the concept of computer literacy and of young people working with computers has a deceptive allure due to the fact that the degree of skill involved has been grossly over-estimated. He suggests that this allure has masked the realisation that access to and working with computers has the more basic underpinning of wealth and class. The ensuing result is that 'Very often the people promoting computer literacy also accept a picture of a stratified society in which there will be a sharp division between the people Adam Osborne calls the capables and the incapables' (Reinecke 1983, p. 187).

Through educative critique the imperative of technological determinism, which conceals powerful interests while segmenting society into an elite and their dependents, might be subject to scrutiny. As I have argued elsewhere:

> it would appear that, unless there is a massive transformation of the economy and society, there will evolve a highly educated elite who will develop and direct the form of technological change, while the majority of society will be occupied in fairly low-skilled service industries. In this way high technology is reinforcing the class nature of society while tending to accentuate the redistribution of power and the creation of increased imbalances between society's economic classes.
>
> (Watkins 1985, pp. 32-3)

Any such transformation must have the school as one of the focal points in promoting educative critical practices. However, it would appear that at present very few schools have tackled at depth the social effects of computers. Yet schools 'Forming attitudes and policies which ameliorate the unemployment created by computer technology and its effects on skills is one of the most pressing social needs' (Reinecke 1983, p. 172). This need might be fulfilled by the Blackburn Report (Ministerial Review of Post-compulsory Schooling 1985) recommendation that the study of work in society be compulsorily undertaken as two units during the last two years of post-compulsory education. The Report suggests that the nature and organisation of work should be examined in its social and historical context. In essence it suggests a dialectic whereby the historical paths and the daily paths of human agency intersect and interact. Or, as the Report proposes, 'It essentially represents a form of socio-economic history brought forward into the present, interacting with the history of technology and involving contact with work places and the life experiences of various older men and women' (Blackburn Report 1985, p. 29).

An educative critical view of technology would focus on the way technology can inhibit or constrain inequalities in the distribution of resources and power. Moreover, it would emphasise that technology when viewed in a certain light presents a particular ideology of the world (see Watkins 1985). In contrast a functional determinist view merely tends to facilitate a process whereby the essential facets of the *status quo* are reproduced. In educating students on the creation and implementation of technology there is a need to bring about an understanding of the way technology interacts with social structures to produce and reproduce a particular construction of reality. Such a critical educative practice should also provide a capacity to illustrate where and how change might be generated from within the totality of society. As Connell et al. argue, 'The business of school is not propaganda; it is equipping people with the knowledge and skills and concepts relevant to remaking a dangerous and disordered world. In the most basic sense, the process of education and the process of liberation are the same' (Connell et al. 1982, p. 208).

To relate this educative experience to the actual practice in schools, Wood (1985) has suggested a number of ways in which meaningful participation in the choice and direction of technological change may be fostered. First, the development of critical basic skills should be a major facet of the school curriculum. Second, schools should strive to give students an understanding of their own historical and cultural context. Through this educative experience students can take up a position whether to support, oppose or change the *status quo*. Third, schools should expose the alternatives, not only in ways of democratic living but also in ways of technological employment. Fourth, so that the fullest degree of participation in choices and decisions may eventuate, change needs to come to the traditional authoritarian structure of schools. Lastly, schools should seek to foster values which facilitate equality, participation and a sense of human emancipation. Through such an educative process people will come to discover that education is not instrumental to a prescribed, predetermined technological necessity but rather technology is subject to human critique, human choice and human agency.

Conclusion

This monograph has attempted to demonstrate that an uncritical acceptance of the technological imperative popularly associated with high tech is likely to lead to contradictory outcomes. In developing this argument the functional determinism on technological change of two scholars, Ellul and Winner, was outlined. They claim that technology has got out of control by developing a life and rationale of its own. This argument leads to the aggregation and reification of the concept of technology. Perhaps most importantly the argument of Winner, in particular, tends to equate all purposive human action with technological change, thus making technology, by definition, all encompassing. The logical extension of this argument is that, on every front, people are dominated by technology. However, the emphasis on technology versus human beings ignores the potential of human beings to devise technological innovations with the capacity to liberate members of society. Technology can have inherent within it a range of values which can influence whether certain outcomes are seen as desirable or otherwise. This element of political reflexivity is a noticeable omission from the deterministic position. By neglecting to reflect on the political, social, economic and historical, especially the pre-modern period, the deterministic approach fosters a sense of helplessness. However, by reflecting on these concerns, a dialectic is revealed which helps dispel any feeling that human beings are now ineffectual in the way technology develops.

In order to place technology within its historical context the next section examined the long-wave theory of Kondratieff. This theory has under-gone a resurgence in popularity over the last ten years. The underlying impetus for this interest has been the economic difficulties which the world has been experiencing over the late 1970s and the first half of the 1980s. A number of theories have been generated which have linked the long wave to swarms of technological innovations, labour markets, inflation and interest rates and class struggle (see van Duijn 1983; and Mandel 1980). Until recently English, Australian and American scholars have not been as enthusiastic about the long-wave theory as their European counterparts. Jones (1982) reflects this reservation by collapsing the waves into what he sees as three major revolutions of technological change. However, more importantly, it can be argued (Mensch 1979) that long-wave theory is basically founded on historical determinism.

The model which most exemplifies the latest revolution or phase of technological change is that of Silicon Valley. It was shown that there have been feverish efforts to copy the development of Silicon Valley in Australia and elsewhere. However, it was pointed out that there are many contradictary elements inherent in Silicon Valley itself. While it may be the Mecca of current high tech the work is frequently arranged on traditional assembly-line methods. The result is that most of the jobs are boring, repetitious and routine. The main effect is to develop a segmented labour market where it seems that women, especially, and recently arrived migrants do the poorly-paid repetitive work, while men, predominantly, occupy the well-paid powerful positions in these corporations. This effect is not confined to Silicon Valley. Recent research indicates that one of the effects of high tech has been to accentuate the patriarchal hierarchy in organisations.

Many educators and educational administrators have argued that children must be more specifically educated, especially in the higher mathematics and sciences, to take their place creating and working the new technology (Pogrow 1983). However, recent research in Australia and the United States of America indicates that it will not be in high tech occupations in which the majority of people will work in the future but in low tech positions, especially in the service sector of the economy. For instance, the work of Levin & Rumberger (1983a, 1983b) indicates that, while there will be undoubted growth in high tech occupations, these jobs make up and will continue to make up only a small percentage of the total labour market. Accordingly, the educational response should not reside in schools responding in a functional fashion to the needs of industry but rather in critically examining the practices and repercussions emanating from human choice in the creation and implementation of technology.

In conclusion it has been argued that education should adopt a critical approach towards new technology. The legitimacy of the new technology, as well as its political foundations and power base, should be open to scrutiny. Through educative critique the apparent logic of determinism would be contrasted with the contradictions uncovered within the existing social order. In this way the functionalist unitary image of society engaging in coherent, rationalised actions would be set against and discarded for the dialectic of actual, daily practice interacting with the bonds of history and society.

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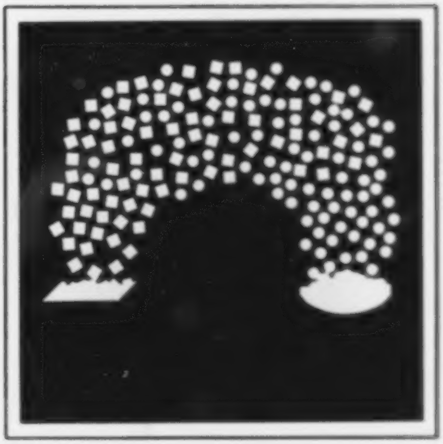
Readings



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Computerization – Taylor's latest disguise

M. Cooley

Source: M. Cooley, 'Computerization – Taylor's latest disguise', *Economic and Industrial Democracy*, vol. 1, no. 4, November 1980, pp. 523–39.

The computer is increasingly being used as a Trojan Horse for Taylorism. We are now beginning to repeat in the intellectual work environment many of the mistakes already made at such cost in the field of manual work. The division of labour is sweeping through the entire spectrum of white-collar work from routine clerical tasks to some of the highest levels of creative activity such as design. Examples are provided of alternative systems which are human centred and enhancing. Whether such systems are implemented is a question of profound ideological and political significance.

There are many contradictions which highlight the problems of our so-called technologically advanced societies. Two of these are directly relevant to what I shall have to say. The first is the growing gap that now exists between that which technology could provide for society (its potential), and that which it actually does provide for society (its reality). We have on the one hand, a level of technological sophistication which can produce systems as complex as Concorde, yet at the same time old age pensioners are dying of hypothermia because they cannot get simple, effective heating systems.

Senior Design Engineers, using the most advanced interactive graphic systems, optimize car bodies so that they are aerodynamically stable at 120 mph when the average speed of a car through New York is 6.2 mph. It was 11 mph at the turn of the century when vehicles were horsedrawn!

Senior electronics and communications engineers are working out complex satellite-based communication systems so that it is possible to send a message around the world in fractions of a second although it now takes longer to send an ordinary letter from Washington to New York than it did in the days of the stage coach, and a second class letter from London to Rome will typically take four weeks.

Likewise, in computer-based work environments, systems and equipment which could liberate human beings to undertake more fulfilling tasks, frequently result in their being reduced to mere machine appendages, acted upon by the system rather than acting on it.

The second contradiction is the terrible wastage that industrial societies make of their most precious asset, which is the skill, the ingenuity, the creativity and sheer enthusiasm of ordinary people (Cooley, 1980). That this should be so should not take us by surprise. Some 30 years ago, that founding father of modern cybernetics, Norbert Wiener pointed out:

> It is easier to set in motion a galley or factory in which human beings are used to a minor part of their capacity only, rather than to create a world in which human beings fully develop. Those striving for power believe that a mechanized concept of human beings constitutes a simple way of realizing their aspirations to power. I maintain that this easy way to power not only destroys all ethical values in human beings, but also the very slight aspiration for the continued existence of mankind (Wiener, 1960).

Yet, in spite of such early warnings, there still persists the widespread belief that automation, computerization, the use of robotic devices and microprocessor-based systems will free human beings from soul destroying, routine, backbreaking tasks, and leave them free to engage in more creative work. It is further suggested that the use of these types of equipment will lead to a shorter working week, longer holidays and more leisure time. It will, in short, improve the quality of our lives. It is usually added as a sort of occupational bonus, that the masses of data available to us will mean that the decisions we make will be that much more logical, scientific and creative.

It will be the object of this paper to question the above assumptions, and to attempt to show that there are now good grounds for believing that we are beginning to repeat in the field of white-collar, intellectual and conceptual work, most of the mistakes we have already made at enormous cost at earlier historical stages when skilled manual work was subjected to technological change. Further, I shall attempt to show that the computer is being used as a Trojan Horse for Taylorism, the division of labour, and the dehumanization of work. This dehumanization is due in large measure to the fragmentation of work into narrow tasks, each minutely timed — the very essence of Scientific Management. As its founder Frederick Winslow Taylor explained: 'The workman is told minutely just what he is to do and how he is to do it, and any improvement he makes upon the orders given him is fatal to success' (Taylor, 1906).

Initially, Taylorism on the shop floor actually increased the intellectual activity of staff in the offices. Taylor himself explained that his system 'is aimed at establishing a clear-cut and novel division of mental and manual labour throughout the workshops.

It is based upon the precise time and motion study of each workman's job in isolation, and relegates the entire mental parts of the tasks in hand to the managerial staff' (Taylor, 1903).

Seventy years of scientific management has seen the fragmentation of work grind through the spectrum of workshop activity engulfing even the most creative and satisfying manual jobs such as toolmaking. Throughout that period, most industrial laboratories, design offices and administrative centres were the sanctuaries of the conceptual, planning and administrative aspects of work. In those areas, one spur to output was a dedication to the task in hand, an interest in it, and the satisfaction of dealing with a job from start to finish.

There were of course, those observers who argued that since in some industries 50 to 60 percent of those employed were scientific, technical and administrative staff, the employer would soon include them in his speedup plans. This line of argument suggested that the more science ceased to be an amateur gentlemen's affair and was integrated into the productive process, the more would scientists and technologists become part of the workforce itself. Indeed, it was even suggested that as high capital equipment such as computers became available to them, scientists and technologists would be paced by the machines. Eventually their intellectual activity would be divided into routine tasks and work studies to set precise times for its synchronization with the rest of the 'rational procedure'.

The father of the computer industry — Charles Babbage — anticipated Taylorism in the intellectual field when he wrote: 'We have already mentioned what may, perhaps, appear paradoxical to some of our readers — that the division of labour can be applied with equal success to mental as well as mechanical operations, and that it ensures in both the same economy of time' (Babbage, 1963).

A paper in the journal *Work Study* (June 1974) suggests that much 'progress' has already been made in this direction. Having identified the hierarchy of physical work as 'Job, Operation, Element, Therblig' it states

> The first three of these are general concepts, i.e., they could apply equally well to mental or physical work. The last term, the therblig, is specific to physical work. All elements of physical work consist of a small number of basic physical motions first codified by Gilbreth (therblig is an anagram of Gilbreth), and later amended by the American Society of Mechanical Engineers and in the British Standard Glossary. The logical pattern would be complete if a similar breakdown of elements into basic mental 'motions' or yalcs were available. (Yalc is an anagram of Clay.)

The paper discusses in detail how to classify input yalcs, output yalcs and processing yalcs. There is a description of how each of these can be subdivided down into basic mental operations. It goes as far as to draw a division between the passive reception of visual signals (seeing) and their active reception (looking); between the passive reception of audio signals (hearing) and their active reception (listening). The paper implies that these techniques will be used in the more clerical aspects of mental work. However, it concludes:

> We have tried to show that mental work is a valid and practical field of application for Work Study, that basic mental motions exist and can be identified and classified in a meaningful way, provided that one does not trespass too far into the more complex mental routines and processes. A set of basic mental motions has been identified, named, described and coded as a basis for future measurement research, leading to the compilation of standard times. There is a good prospect that such times would play a valuable part in Work Study projects.

Whether or not one regards this type of research as pseudoscience, there can be little doubt about how it will be deployed. The employers of scientific, technical and administrative staff (including some forms of managerial staff) will see it as a powerful form of psychological intimidation to mould their intellectual workers to the mental production line. It is perhaps a recognition of this tactical importance which prompted Howard C. Carlson, a General Motors psychologist to say: 'The computer may be to middle management what the assembly line is to the hourly worker' (Carlson in Braverman, 1974). Industrial experience already demonstrates that Taylorism is destined not just for a range of intellectual workers including scientists and technologists. However, it would be quite erroneous too to assume that these techniques will be limited to industrial fields. Even in the most non-alienating forms of work, such as in universities, Taylorist notions are still succeeding in penetrating those ivory towers. We now have the rather ironic development in which some of those who at university helped to develop the scientific management production systems which made work so grotesque for those on the shop floor, may soon be the victims of their own repressive techniques. An article in the *Academy of Management Journal* (Vol. 17, No. 2: 306) is symptomatic of a general tendency.

The terminology used to describe academic features and activities in the form of a factory model is strongly indicative of the underlying philosophy. Thus, the recruitment of students is referred to as 'material procurement', recruiting of faculty as 'resource planning and development', faculty research and study as 'supplies procurement', instructional methods planning as 'process planning', examinations and award of credits as 'quality control', instructor evaluation as 'resource maintenance', and graduation as 'delivery'. The professors and the lecturers are of course 'operators' and presumably, as on the shop floor, only the effective operators can be tolerated (effective for what? and for whom? we may ask).

Even when the more genteel 'services model' is compared with the 'factory model' the conclusion is significant: 'A goal under both models is to obtain the most effective and efficient operators as possible. The difference is one of emphasis. In the factory model, administrators are responsible for the competence of the faculty operators'. It is of course highly likely that the administrators' definition of 'competence' may well dent many of the cherished academic freedoms whether real or imaginary. Perhaps in the not too distant future, many faculty members will find themselves subordinated to the process in the interests of efficiency, as are workers on the shop floor.

Those academics engaged in the physical and pure sciences will be pleased to learn that these important issues of efficiency and optimization will not be left to the subjective ramblings of the sociologists or the tainted ideology of the political economists. The full analytical power and neutrality of 'real science' and the penetrating logic of mathematical method have been brought to bear. They will undoubtedly produce a completely 'objective' solution. For example, Geoffrion, Dyer and Freiberg use the well known Frank-Wolfe algorithm and propose that the multicriterion problem be considered in the following form:

> Maximize $U\,[f_1(x), f_2(x), \ldots f_r(x)]$, subject to $x \in X$ where $f_1 \ldots f_r$ are r distinct criterion functions of the decision vector x, X is the constrained set of feasible decisions, and U is the decision-maker's overall preference function defined in the values of criteria.

Taking a specific departmental example, they define six criteria for it. The first three criteria of the model are the number of course sections offered by the department at graduate, lower division undergraduate and upper division undergraduate levels. Criterion four is the amount of teaching assistant time used for the support of classroom instruction by the faculty. The fifth criterion is the regular faculty effort devoted to major departmental duties measured in equivalent course sections. Finally, criterion six is the regular faculty effort devoted to additional activities such as research, student counselling and minor administrative tasks, again measured in course sections.

Terms such as 'teaching time', 'teaching loads' and 'faculty effort' are used throughout. This will mean that whoever makes a decision about criterion weight must have very precise times for the different functions, and thus the basis is clearly set for work measurement not unlike that on the shop floor. The justification will undoubtedly be that such times are necessary to be fed into the computerized model for objective assessment.

Despite the veneer of mathematical objectivity, however, the key U function remains based entirely on the subjective judgment of the so-called decision-maker. This decision-maker will be an administrator; therefore the academic staff will experience a very considerable loss of control over their own work environment. If in future a faculty member is informed via the computer that he or she is taking too long on teaching, or spending too much time on research, or has been rendered superfluous through an optimization routine (a function which mathematically illiterate manual workers call 'the sack'), it will be worth recalling that it is the U function that predominates.

Programmes to increase faculty productivity are already spreading rapidly in the United States; recent grants indicate the potential scale. For example, a centre for professional development was set up in the California State University and College System with a grant of 341,261 dollars from the Fund for the Improvement of Post Secondary Education in Washington.

A comprehensive faculty activity analysis questionnaire has been prepared and developed by the University of Washington (*Times Higher Education Supplement*, 14 February 1975: 14). The actual percentage time devoted to each faculty activity is requested. All university activities, whether regular or irregular, are defined and coded. For example, code 501 — unscheduled teaching — includes thesis committee participation, discussion with colleagues about teaching, guest lecturing in other faculty members' courses, and giving seminars within the institution. Each activity is specified very precisely as it might be in a factory situation. Under the code 'Specific Scholarly Project' are listed departmental research, sponsored research, writing or developing research proposals, writing books and articles and many more. Even one's own reading activities are included. Thus under 'General Scholarly Projects' we find: reading articles and books related to the profession, attending professional meetings, research related discussions with colleagues and reviewing colleagues' research work.

There are some academics who hope that in projects of this kind, educational requirements will outweigh mere productivity considerations. However, a growing sector feel the outcome will be a smaller faculty teaching more classes and more students. This has already happened at the City University of New York where 700 faculty members were sacked (*New Scientist*, 22 April 1976: 178).

Increased 'productivity', however, could have consequences much more widespread and subtle than the obvious ones of increased work tempo, loss of control, job insecurity and even redundancy. The impact it will have on the creativity of those involved is likely to be significant, for central to all optimization procedures of this kind is the notion of specific goal objectives.

The overexact specification of goal objectives, and the increased reliance on optimized procedures, constrains the 'search area' of the intellectual worker, and provides a total working environment oddly at variance with the circumstances and attributes which appear to have contributed to creativity in the past (Beveridge, 1961; Eiseley, 1962; Fabun in *Kaiser Aluminium News*, Vol. 25, No. 3).

Computer Aided Design (CAD) is a useful occupational aperture through which to view a scenario that will become commonplace to many in the next few years. In selling the idea of computers to the design community, it is suggested that the computer will merely deal with the quantitative factors and the designer will deal with the value judgments and the creative elements of the design process. It is of course true that the design process is, amongst other things, an interaction of the quantitative and the qualitative. It is not, however, true that design methodology is such that these can be separated into two disconnected elements which can then be applied almost as a chemical compound. The process by which these two opposites are united by the designer to produce a new whole is a complex and as yet ill-defined and ill-researched area. The sequential basis on which the elements interact is of extreme importance.

The nature of the sequential interaction, and indeed the ration of the quantitative to the qualitative, depends on the commodity under design consideration. Even where an attempt is made to define the proportion of the work that is creative and the proportion that is non-creative, what cannot readily be stated is the stage at which the creative element has to be introduced when a certain stage of the non-creative work has been completed. The very subtle process by which designers review the quantitative information they have assembled and then make the qualitative judgement, is extremely complex. Those who seek to introduce computerized equipment into this interaction attempt to suggest that the quantitative and the qualitative can be arbitrarily divided so that the computer will handle the quantitative. This is really a devious introduction of Taylorism into advanced technological work, i.e. an attempt to further subdivide an 'intellectual activity' into its 'manual' and 'intellectual' components.

Since CAD drastically increases the rate at which the quantitative is handled, a serious distortion of this dialectical interaction takes place — frequently to the detriment of the qualitative. There are, therefore, good grounds for assuming that the crude introduction of the computer into the design process, in keeping with the Western ethic of 'the faster, the better', may well result in a deterioration of the design quality. It is typical of the narrow, fragmented and short-term view which capitalism takes of all productive processes, that these important philosophical considerations are ignored. Much design research is limited to considerations of design techniques and associated hardware and software with precious little regard for the objective requirements of the design staff or, more importantly, the public. Such research accurately reflects our economic base which puts equipment (and hence capital) first, and people last.

Elitist designers, steeped in their traditional professionalism, believed (and many still believe) that their creative talents provide an eternal occupational sanctuary against the creeping proletarianization of all white-collar workers. Architects, for example, concede that there might be problems for aircraft designers, mechanical designers or civil engineers, but not for them. After all, is not architecture the 'Queen of the Arts' rather than the father of technology? However, capitalism in its relentless drive to exploit all who work, has not forgotten the architects. For them there has been specifically produced a software package known (appropriately) as HARNESS. The concept behind this system is that the design of buildings can be systematized to such an extent that each building is regarded as a communication route. Stored within the computer system are a number of predetermined architectural elements which can be disposed around the communication route on a Visual Display Unit in order to produce different building configurations. Only these predetermined elements may be used and architects are reduced to operating a sophisticated 'lego' set. Their creativity is limited to choosing how the elements will be disposed, rather than considering in a panoramic way the types and forms of elements which might be used. As Marx pointed out in *Capital*:

> A bee puts to shame many an architect in the construction of its cells; but what distinguishes the worst of architects from the best of bees is namely this — the architect raises in his imagination that which he will ultimately erect in reality. At the end of every labour process, we get a result that already existed in the imagination of the labourer at its commencement (Marx, 1974: 174).

It is clear that HARNESS will reduce the distinction between the architect and the bee, and that capitalism will insist that in future architects will work in a more 'bee-like' manner. This will gradually apply to all technological and scientific workers, whatever systems are devised to control their 'mode of intellectual production', in the same way as manual workers on the shop floor are controlled.

The extent of the control which new technology provides over formerly skilled manual workers, and the extent to which they are deskilled by these processes, is highlighted dramatically by a recent report in the *American Machinist* (July 1979) which pointed out that the ideal workers for numerically controlled machine tools are mentally retarded workers. It specifically mentions a mental age of twelve. This is in glaring contrast with the predictions of some industrial sociologists that the new technologies would elevate the worker to a form of manager, where through the computer they would have a panoramic view of the previously fragmented parts of the process, and would use the computer as a means of 'managing' them.

The notion of the division of labour and the efficiency which is said to flow from it is normally associated with Adam Smith (1937). In fact, Adam Smith's specific arguments were anticipated by Henry Martyn almost a century earlier (1801). However, the basic notion of the division of labour is so intertwined with Western philosophy and scientific methodology that it is identifiable as far back as Plato when he argues for political institutions of the Republic on the basis of the virtues of specialization in the economic sphere.

The divsion of labour and fragmentation of skills is of course absolutely rational if you regard people as mere units of production and are concerned solely with the maximization of the profit you extract from them. Indeed, viewed from that premise, it is not merely rational but also scientific. The scale and nature of the deskilling which accompanies this scientific management has been graphically described by Braverman (1974). This deskilling stretches right through the intellectual field. One researcher who has examined the effects of automation in Swedish banks says: 'Increased automation converted tellers, who were in effect mini bankers, into automatons' (Docherty, 1978).

It might be argued in defence of these developments that at least in the 'occupational growth areas' associated with computing, those workers concerned with issuing instructions to the machines will be undertaking work of growing skill and complexity. To suggest this would be to fail completely to understand the historical tendency to deskill *all* work. Programming itself is being reduced to routines and 'the deskiller is deskilled' as structured programming breaks with the universal (if short) tradition of idiosyncratic software production (Kraft, 1977).

That all of this is happening in the field of the new technology should not surprise us (Cooley, 1980). The controllers of the vast corporations designing and building computer-based systems are often, in unguarded moments, remarkably frank about the political nature of the new technology. Franco di Benedetti, Joint Managing Director of Olivettis, recently said this about the new technology:

> It is basically a technology of co-ordination and control over a workforce, the white collar workers which (traditionally) organization does not cover. In this sense, E.D.P. is in fact an organizational technology, and like the organization of labour has a dual function as a productive force and a control tool for capital (Kraft, 1980).

The use of the new technology has been described by the UAW researcher Harley Shaiken as 'Power masquerading as technology' (Shaiken, 1980).

I have suggested earlier (Cooley, 1979) that science and technology is not neutral, but reflects the economic base which gave rise to it. If this be correct, then the use/abuse model will be inadequate to explain the contradictions we see in technologically advanced society. We shall have to probe deeper.

Technological change has certainly been used, not merely to increase productivity, but to extend control over those who work within these processes. Further, Noble has brilliantly demonstrated that engineers, in the application of science and technology, have been serving and advancing the cause of Corporate Capitalism (Noble, 1977). I have questioned whether the means of production so developed would be appropriate in a society where human beings could develop their potential to the full, even when the ownership of the means of production is 'in the hands of the people'.

Science as practised in the technologically 'advanced' nations, and I would include here the so-called socialist countries, shares with Taylorism the methodological assumptions of predictability, repeatability and quantifiability. If one accepts these to be tenets of the scientific method, it then follows that to be scientific implies eliminating human judgment, uncertainty and the subjective. Yet skill, in the manual and intellectual sense, can be closely related to the ability to handle uncertainty. Skilled work, we may say, is work of risk and uncertainty, whereas unskilled work is work of certainty.

The contrast between a skilled turner using a universal lathe, and an unskilled worker on an NC machine will illustrate the point, as will the contrast between a conventional designer and one using a 'design manual' type of computer aided design system. Further, the exercise of skills is an important learning and developing process. If, therefore, we regard it as desirable to enhance human skill and ability (and I do) then we have to design systems which are responsive to human judgments, and which respond to the persons using them rather than acting upon them. The telechiric devices suggested by the Lucas Aerospace Combine Shop Stewards Committee begin to address this problem (Cooley, 1977). Other ideas are being explored which, in embryo, start to point the way to a human enhancing, liberatory form of technology. Two examples only will be given here to illustrate the possibilities — one in the field of manual work, the other in the field of intellectual work.

Over the past 200 years, turning has been one of the highly-skilled jobs to be found in most engineering workshops. Tool-room turning is one of the most highly skilled jobs of all. The historical tendency, certainly since the war, has been to deskill this function by using NC machines. This is done by Part Programming — a process by which the desired NC tool motions are converted to finished tapes. Conventional (symbolic) part programming languages require that a part programmer, upon deciding how a part is to be machined, describes the desired tool motions by a series of symbolic commands. These commands are used to define geometric entities, that is, points lines and surfaces which may be given symbolic names. In practice, the part programming languages require the operator to synthesize the desired tool motion from a restricted available vocabulary of symbolic commands. However, all this is doing is attempting to build into the machine the intelligence that would have been exercised by a skilled worker in going through the labour process.

It is possible, by using computerized equipment in a symbiotic way, to link it to the skills of a human being and define the tool motions without symbolic description. Such a method is called

Analogic Part Programming (Gossard and von Turkovich, 1978). In this type of part programming tool motion information is conveyed in analog form by turning a crank using readout with precision adequate for the machining process. Using a dynamic visual display of the entire working area of the machine tool including the workpiece, the fixturing, the cutting tool and its position, the skilled craftsman can directly input the desired tool motions to 'machine' the workpiece in the display.

Such a system, which may be described as 'Part Programming by Doing' would represent a sharp contrast to the main historical tendency towards Symbolic Part Programming. It would require no knowledge of conventional part programming languages because the necessity to describe symbolically the desired tool motions would be eliminated. This is achieved by providing a system whereby the information regarding a cut is conveyed in a manner closely resembling the conceptual process of the skilled machinist. Thus, it would be necessary to maintain and enhance the skill and ability of a range of craftsmen and women who would work in parallel with the system. Significant research has been carried out in this field (Gossard, 1975), yet in spite of its obvious advantages, it has not been received with any enthusiasm by large corporations or indeed funding bodies. That this is so would appear to be an entirely 'political judgment' rather than a technological one.

In the field of intellectual work, Rosenbrock has questioned the underlying assumptions of the manner in which we are developing computer-aided design systems. He charges, firstly, that the present techniques fail to exploit the opportunity which interactive computing can offer. The computer and the human mind have quite different but complementary abilities. The computer excels in analysis and numerical computation. The human mind excels in pattern recognition, the assessment of complicated situations and the intuitive leap to new solutions. If these different abilities can be combined, they amount to something much more powerful and effective than anything we have had before. Rosenbrock objects to the 'Automated Manual' type of system since it represents, as he says, 'a loss of nerve, a loss of belief in human abilities, and a further unthinking application of the doctrine of the Division of Labour' (1977a). As in the case of turning described above, Rosenbrock sees two paths open in respect of design. The first is to accept the skill and knowledge of the designer, and to attempt to give designers improved techniques and improved facilities for exercising their knowledge and skill. Such a system would demand a truly interactive use of computers in a way that allows the very different capabilities of the computer and the human mind to be used to the full. The alternative to this, he suggests, is 'to subdivide and codify the design process, incorporating the knowledge of the existing designers so that it is reduced to a sequence of simple choices' (1977b). This, he points out, would lead to a deskilling such that the job can be done by a person with less training and less experience.

Rosenbrock has demonstrated the first human enhancing alternative by developing a CAD system with graphic output to develop displays from which the designer can assess stability, speed of response, sensitivity to disturbance and other properties of the system. If, having looked at the displays, the performance of the system is not satisfactory, the displays will suggest how it can be improved. In this respect the displays carry on the long tradition of early pencil and paper methods, but of course they bring with them much greater computing power. Thus, as with the lathe and the skilled turner, so also with the VDU and the designer. Possibilities exist for a symbiotic relationship between the worker and the equipment. In both cases, tacit knowledge and experience is accepted as valid and is enhanced and developed. In Rosenbrock's case, it was necessary to examine the underlying mathematical techniques involved in Control Systems Design (1974). The outcome of his work does demonstrate in embryo that there are other alternatives if we are prepared to explore them, and he has suggested that we are now at a unique historical turning point and may close off options which are now open to us. This process he has described as the 'Lushai Hills Effect' (1979).

These examples have been quoted to demonstrate that it is possible to so design systems as to enhance human beings rather than to diminish them and subordinate them to the machine. It is my view that systems of this kind, however desirable they may be, will not be developed and widely applied since they challenge power structures in society. Those who have power in society, epitomized by the vast multinational corporations, are concerned with extending their power and gaining control over human beings rather than with liberating them.

Such a viewpoint may appear abnormally sectarian or political to some readers. Yet they only have to look at the headlines of the technical press to see statements which completely reinforce that analysis. Thus, a headline in the *Engineer* recently stated 'People are trouble but machines obey' (14 September 1978: 24-5), and even in economic papers one finds headlines such as 'Robots Don't Strike' (*The Economist*, 14 July 1973: 71).

It is not suggested here that engineers who design conventional systems are hideous fascists who deliberately engage in this design in order to subordinate others to the control of the machine and the organizations that own the machine. What I am suggesting, however, is that they are dangerously mistaken in regarding their work as being neutral. Such a naive view was ruthlessly exploited in the Third Reich as Albert Speer (1970) pointed out in his book *Inside the Third Reich*:

> Basically, I exploited the phenomenon of the technician's often blind devotion to his task. Because of what appeared to be the moral neutrality of technology, these people were without any scruples about their activities.

Science and technology is not neutral, and we must at all times expose its underlying assumptions. We can at the same time begin to indicate how science and technology might be applied in the interests of the people as a whole rather than to maximize profits for the few.

The choices are essentially political and ideological rather than technological. As we design technological systems, we are in fact designing sets of social relationships and as we question those social relationships and attempt to design systems differently, we are then beginning to challenge, in a political way, power structures in society.

The alternatives are stark. Either we will have a future in which human beings are reduced to a sort of bee-like behaviour, reacting to the systems and equipment specified for them; or we will have a future in which masses of people, conscious of their skills and abilities in both a political and a technical sense, decide that they are going to be the architects of a new form of technological development which will enhance human creativity and mean more freedom of choice and expression rather than less. The truth is, we shall have to make the profound decision as to whether we intend to act as architects or behave like bees.

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2

Kentucky-fried money: The banks

A. Game & R. Pringle

Source: A. Game & R. Pringle, *Gender at Work*, George Allen & Unwin, Sydney, 1983, pp. 41–58.

In February 1982 a personnel manager in one of Australia's most conservative banks organised a 'women at work' get-together of eight 'career' women, to which we were invited. Three years earlier, when we began research on the banks, we experienced considerable difficulty getting interviews with people in this bank. Now there is a change of image: the bank provides job and career opportunities for women.

Well, what has changed, and why? Here is what these women had to say on the position of women in banks:

> As a matter of fact my first appointment was as manager's assistant. I had to go and ask for it because I was dealing with managers and accountants and had no status whatever and, I thought, this is wrong. I took the view that if you got a good report you were considered as such . . . then I realised that the banks were so conservative at that time [early 1970s] that you had to get off your bottom and do it yourself. I then received a managerial appointment. . . . Previously they always had a male to come in and do the job . . . and I had to more or less do it for him and advise him . . . with industrial work you had to know all the awards and he of course just didn't know it . . . that happened right through my career and I'm sure it happened to the other girls here. . . . When I was in the ledger department, supervisors used to come in when I was examiner and they'd ring my desk and say, teach them what goes on down here . . . and the next thing I knew they'd be my supervisor. But that was something we accepted . . . I think we were brainwashed . . . in my time that's what happened. The girls thought that if you had a good report you'd be looked after—that was not the case. (Manager, Services Staff Administration; has been with the bank 33 years)

> There is some stage where you say, no more . . . are you going to train the next person to be your supervisor . . . I think you do come to that stage where you have that discussion with your accountant one afternoon. . . . For all the publicity, you still have to ask for promotion and there's a lot of nepotism. (Manager's Assistant)

> I had to write a stinking letter to personnel to get out [of examining], and was classified as a stirrer. I came up against a bit of hostility. I became a general hand and was in charge of the tellers . . . and the first teller wouldn't speak to me because he had wanted that job and the accountant wouldn't speak to me because he had wanted a male. . . . The bank's got their tuppence worth out of me . . . (Senior Research Officer)

> I've never asked for it . . . been in the bank 20 years . . . appointed in 1975. . . . In staff training for twelve months before I was appointed as a senior instructor . . . I instructed induction courses right through to accountant before that. (Accountant)

> I think it's going to get more difficult. There were a few years when they thought they had to [promote women] because of equal rights. It'll slow down after accountant level. There are already guys who've done advanced management training. They've been promised jobs but there just aren't the jobs there for them. There's guys around now who are in their forties and haven't got manager's jobs. (Accountant)

Male recruitment?

> It's a banking image problem—the males think, well there's not going to be enough careers, so why bother, there's no incentive . . . if people still think of a male as a breadwinner. (Assistant to Manager)

> People get accustomed to the change . . . they no longer comment on a female accountant and they're mostly surprised to see a male teller there days. (Accountant)

Mobility

> What irks me is that I was never *asked* if I wanted to go anywhere. The guys were asked if they wanted to go to New Guinea. When I approached my boss he said, you wouldn't want to go anywhere, you'd want to stay here. . . . And I said, well until you ask me you don't know . . . So I'll wait and see whether he does. I didn't want to go to New Guinea anyway . . . but it worries me, other people are going past you. (Senior Research Officer)

Cash shops

> That's an area be well out of. That is where they'll shunt women. . . . They'll say, oh yes you're a bank manager . . . you'll only be able to lend up to $15,000 which won't even buy a house . . . (Manager's Assistant)

> All the managers are a little worried because they're not going to go anywhere . . . so if they're not going anywhere what chances have we got of going? (Accountant)

These women spoke openly about discrimination, and were cynical about the opportunities for women when career opportunities for men are so limited. They, along with many other women we spoke to, see bank work as women's work now, precisely because of the lack of careers.

Banking provides a good case study of the relation between 'feminisation' and the process that is often conceptualised as 'proletarianisation' of the workforce. Sociologists have argued that feminisation acts as a counter to proletarianisation and provides the basis of separation between blue collar and clerical occupations (Giddens, 1973; Edwards, 1979; West, 1978). Such claims need to be looked at critically. To argue that clerical workers fail to develop working class consciousness because they are women is simplistic and sexist.

Banking does not fit neatly into the accounts, by Braverman and subsequent sociologists, of the similarities between the office and the factory and the transformation of the all-round clerical worker into a subdivided detail worker (Braverman, 1974; Nakano Glenn & Feldberg, 1979; de Kadt, 1979). Until very recently it has continued to be viewed as an area of predominantly mental labour providing middle-class careers. However, since World War II there have been continuous changes in the way bank work is organised and in the composition of the workforce. Technological change has increased the proportion of repetitive, routinised jobs and affected the career structure and employment opportunities. Women have moved from being a small proportion of bank staff (22.5 per cent in 1950) to about half (46.3 per cent in 1978). Banking is now dominated by very young workers, with one-third being under 21, and the majority under 27.

Technological change in the banking industry

The finance sector expanded rapidly in the postwar boom years. The mass production of goods had to be financed and so did the mass consumption of them. The extension of consumer credit facilities and the growth of hire purchase made it possible for the working class to acquire cars and a wide range of consumer durables such as refrigerators and washing machines. Home ownership increased by 15 per cent between 1947 and 1954 to reach 63 per cent in Australia as a whole (Kemeny, 1977: 83). By 1966 it had risen to 72 per cent though it declined thereafter (Australian Institute of Urban Studies, 1975: 7). The banks opened up new branches to cater for a growing population and new demands on the services. The expansion of savings and cheque accounts far exceeded population growth. On top of this the services became much more varied as the private banks moved into the savings field after 1956 as well as into hire purchase and unit trusts. This was followed by such things as travel departments, the extension of personal loans and, by the 1970s, Bankcard. In order to compete with other financial institutions the banks set up their own finance companies and took shares in (largely foreign-owned) merchant banks.

The bread and butter of banking is the processing of savings and current accounts. This is both labour intensive and the least profitable area of operations. The banks have a lot of capital and a vast workforce tied up in the branches while their main profits are coming from funds management, company accounts, and foreign exchange dealings. They have thus had every motivation to make labour more efficient and reduce costs. Mechanisation in the banks began with the introduction of ledger machines in the 1950s and proof machines in the 1960s but it was computerisation in the late 1960s that led to drastic changes in the labour process. Almost overnight it made ledger machinists and exchange clerks ancient history, centralising these functions in the electronic data processing (EDP) centres. By the early 1970s all the major savings and trading banks in Australia had established EDP centres, with the result that much of the work previously performed in branches is now centralised. Most branches in the main capital cities are now in networks linked to the computer centres and, apart from smaller branches which are still off-line (not directly connected to the computer), the majority are now on-line. This has meant a drastic rationalsation and reorganisation of the work process and the staffing arrangements in branches. The labour-saving effect has been massive.

Before computerisation each branch in a bank ran its own ledger system; different machines and systems were frequently used from one branch to another. With computerisation there is one set of programs; all accounting for all branches is dealt with centrally; calculation of fees, records of accounts and other such work has been removed from the branches. This represents a loss of autonomy for branches. Electronic machines and computer terminals in branches now record and transmit information which is processed and stored in the computer centre. Depending on the specific bank's system and level of automation, some processing takes place within branches. However, the back office work has been drastically reduced as information is punched into the terminals.

A number of stages in the labour process are now combined or reduced with this form of automation. Electronic machines both process work and record it. Proofing machines prove trading bank work, sort it and encode it. Prior to the introduction of these machines tellers proved their own work. Cheques are no longer posted in a ledger in the branch on which they were drawn but simply returned with a computer print out, the information having been centrally recorded. In the case of savings bank work, back office work is reduced as the teller uses the terminal to check the balance in the account.

The full potential of computerisation is now becoming clear, with area banking, automated telling, electronic funds transfer systems and the decline of branch banking becoming a reality. These changes are taking place in the context of the current rationalisation of the banking industry. Following the recent mergers/takeovers there are now only three major private banks in Australia. The Bank of Adelaide merged with the ANZ in 1979 after the collapse of its subsidiary the Finance Corporation of Australia Ltd. In 1981 the CBA was taken over by the Bank of NSW (which has now changed its name to Westpac) and the National merged with the CBC. In the aftermath of the Campbell report the finance sector as a whole is experiencing a major shake up: building societies and insurance companies are also merging.

Banks have been at a competitive disadvantage in relation to other financial institutions because of the labour costs associated with retail operations (branch networks) and government controls, particularly with regard to lending. With deregulation, recommended by Campbell, the shift into the wholesale area of corporate lending and foreign exchange and out of retail will be hastened. If social relations of work are sexualised, so also is the language of capital; as the *Australian Financial Review* put it, 'Although the marriage has already taken place, the wedding night is not until October, 1982.' (13 October 1981). The two recent 'marriages' will facilitate rationalisation of the branch networks: they can now be cut by half. Branch networks are also being reorganised with the introduction of area banking. The ANZ opened its first area branch in 1975 and now the Commonwealth and other private banks are moving into it. In each major area there is one large branch, with several smaller ones around it, but the bulk of the work, company accounts and major lending, is handled in the area branch. This amounts to a further downgrading of branches and of the status of many branch managers who will be little more than glorified supervisors. The new branches are called service centres or cash shops: 'piggy banks with junior managers'. When these are established, batching, that is the machining work now done in branches, will probably be centralised in a 'factory' in each area. It is claimed that the increased volume could 'save' four or five staff per branch. These changes will have severe effects on the workforce and it is not just junior staff who will bear the brunt: managers and people in head office are anxious about their futures also. Computerised systems like EFTS and automated tellers have less to do with 'convenient customer service' than efficient transfer of funds and rationalisation of branch work. Bank service is declining as rapidly as interest rates are rising.

Banking has always been seen as a career industry. The career structure is pyramid-shaped and very broad-based. The vast majority of staff are recruited at school-leaving age and may work their way up the pyramid through in-service training courses and good annual reports. The banks have always had a policy of 'growing their own' supervisory and managerial staff. Thus it is theoretically possible to start as messenger boy and work your way up to managing director. (No one ever speaks of messenger girls.)

Bank workers are not paid according to skill but according to age and sex. As with all clerical and administrative work, there have never been the clear skill differentials that exist in manufacturing industry and are associated with manual work. In contrast the 'mental' labour associated with white collar work has enabled bank employees to experience themselves as middle class. In fact, the majority of bank workers have probably always been part of the working class or close to it. The 'mental' labour of most bank clerks is minimal.

A pyramid, by definition, excludes most from the higher levels. What is significant about career structures in white-collar work is the ideology that attaches to them, that everyone has the opportunity to move into the ranks of management. This operates as a powerful means of control of the workforce. Bank work held out the possibility of upward mobility for the children of the lower middle class, especially in rural areas, and some sections of the working class. Such people were likely to be much more closely aligned with management ideologically than was the case in manufacturing. And it was precisely the middle class virtues of respectability, hard work, thrift, and sobriety that had to be cultivated if the transition were to be made. Bank workers handle money which symbolises an ultimate and objective measure of efficiency.

This system had considerable advantages for the banks. Everyone was assumed to be motivated towards achieving promotion and even today bank people talk about the importance of keeping up with their peers. It was easy to shift people around to any type of work without demarcation disputes or skill differentials to consider. This has made it relatively easy to introduce labour-saving technology and rationalisation of the labour process based on the advice of efficiency experts and work value studies.

But we have told only half the story. The career structure, which enabled banking to be treated as an avenue to secure, if not lavish, middle classness, applied to men only. Until the late 1960s women were obliged to resign from the permanent staff upon marriage. Until 1975 there were quite separate classification scales for men and women. Women were paid considerably less and were not eligible for the career grades. The career pyramid depended increasingly on the fact that much of the most menial work could be classified separately, and thus be lower paid, because it was being done by women.

Feminisation and the labour process

Women moved into the banks during World War II (24.4 per cent of the workforce in 1945) when they became ledgerkeepers and relief tellers. After the war they stayed because from the early 1950s onwards ledgerkeeping became mechanised and women were seen as more suitable to operate the machines. Ledgerkeeping was once the place where the majority of male clerks started off their careers. Machines were first introduced at some head offices and city branches in the 1930s. They were extended to other city and some suburban branches in the early 1950s and then became general. The first machines prepared statements and were used in conjunction with manually posted ledgers. Men and women thus worked side-by-side, men doing the hand posting and women operating the machines. In the 1960s these processes came together. The Dual Post System could be adjusted to post either ledger or statement sheets and the side-by-side system, though slower, could post the statement and ledger sheets simultaneously. The result of this was to halve the number of staff involved and to feminise the area. Women were using adding machines to balance up transactions, deposit child endowment payments, close accounts, handle transfer accounts, lost passbooks, and register signatures at other branches.

Women were thus moving into more central areas of banking, albeit at the lowest levels, but the ideology still prevailed that they were not really part of the bank. The ledger machinists were deliberately kept 'out of the firing line', ostensibly away from customers, in reality away from the wider activities of the bank, so that they could work harder. They were located at the back of the bank, face to the wall, working under conditions that the male clerks would not have tolerated. Thus productivity was increased not only by mechanisation but by the way work was organised.

Up to the mid 1960s the movement of women into the banks was directly related to mechanisation. They operated ledger and proof machines, taking over the most menial and lowest paid jobs. That this represented qualitative changes in the nature of bank work was disguised by the fact that it was being done by women.

In the period since 1965 major changes have taken place. The banks dropped their marriage bars and slowly opened up their career positions to women. Although the separate male and female classifications were retained, 'selected duties' schemes enabled some women to undertake telling and examining duties, though they were not allowed to progress any further. They were paid the male rates while they were doing these jobs but only after union pressure. This still did not amount to the full margins because the banks argued that although they were doing the same work as male examiners the males were younger and the appropriate scale was thus the male age scale adjusted downwards three years! The union refers to this as the 'three wise monkey's decision' in honour of the three members of the Full Bench. In addition, this 'promotion' was still along the women's line and thus constituted no challenge to the male career structure. At about the same time provision was made for a tiny minority of women to advance to senior supervisory positions. In the Commonwealth Bank this was known as the 'Women's Advanced Appointments Scheme', which took one batch of 30 women in 1968, its first year of operation. Similar schemes were set up in the other banks but the numbers likewise remained small. Following the 'equal pay for work of equal value' case in 1972, opportunities for women widened slightly. By the end of 1974, more than half of the women in banks, mainly 'junior' staff, were officially on equal pay though the discriminatory pay structure was not dismantled until 1975, following arbitration proceedings to enforce full equal pay. At that stage these two schemes were dropped and women were moved into the general classification.

As it stands at the moment, women have formal equality of opportunity: there is one general classification for men and women. In the specially classified grades there are still distinctions between keyboard and supervisory/managerial positions. These are not based on sex as such (though no men have as yet been appointed to the keyboard area!) and it is possible for people to move across from keyboard to supervisory levels.

A concern with sexual equality was not what motivated the banks to bring in these changes. Certainly the rising proportion of women employees did make it likely that pressure would be brought to bear. There was considerable bitterness amongst many of the senior women who often had responsibility for large numbers of staff, yet they suffered the indignity of seeing young boys paid more than they were and shooting up rapidly through the career grades. These women began to organise and to apply for male jobs for which they regarded themselves as qualified, in order to draw attention to the injustice. In the Commonwealth Bank they set up a Women's Advisory Council (WAC) which worked closely with the Commonwealth Bank Officers' Association (CBOA), in preparing cases for the Arbitration Commission. Female militancy coincided with the emergence for the first time of more general union militancy over pay and conditions. Yet the banks were curiously unmoved by this. The Commonwealth Bank claimed to have been little influenced by the WAC which merely 'let the girls think they had an outlet'. Presumably the numbers concerned were so small, approaches so timid, and organisation so limited, that the banks saw no serious threat to industrial relations.

Industrial legislation in the field of equal pay was only one of the factors, and not the most important, which determined bank policy on female employment. With equal pay the banks naturally moved women into previously male areas in order to 'get their money's worth' out of them, but, well before this, bank policies were changing in ways that would be hailed, retrospectively, as having 'anticipated' equal pay. In the first place, by the late 1960s, the banks were faced with practical difficulties in filling the telling line. In an expansionary period the occupation of bank clerk was becoming a less attractive choice for young men. On top of this, the proportion of the workforce under 20, from which the banks drew their staff, was declining. It was 13.7 per cent in 1966 and 11 per cent ten years later. The increase in university enrolments during this period meant a further decline in the number of young men available while the proportion of married women in the workforce was increasing. There was thus a relative shortage of males and an abundance of females. By putting women on the counter and paying them the full margin the banks could take on as married women, 'girls' they had previously trained.

Secondly, there was a desire to restrict male recruitment to longer-term executive needs. By this time the rate of expansion of branches was declining and a lot of labour-intensive work was disappearing. It could be anticipated that there would be less need for the supervisory positions to which men had traditionally been promoted. Thus a conscious decision was taken to change the mix of short-term and long-term career staff. Women have a very high drop-out rate and the banks can quite confidently predict how many will leave after four or five years. Most leave to have children by about age 25. While increasing numbers are making it to junior supervisory positions the number who go much further tapers off quite dramatically. Most have dropped out by the age 30. Natural wastage thus sorts out the problem of promoting large numbers to low level management.

The women who make it

Although very few women make it into management, some reach senior positions. These are predominantly older women who have worked in the banks for many years. The larger proportion of women in the bank workforce has also resulted in some making it into junior 'management'. Much the same process has occurred in retailing, as we show in the next chapter. A consideration of some representative cases shows how these women have 'slipped through' the types of obstacles faced by most.

Section officer in a savings bank

A softly spoken woman in her late fifties, Jane is perhaps the most senior woman in administration. She is highly competent but has not been one to push herself. She conceded that she was emotionally discomforted by having to be an equal with men, though intellectually she approved. Jane joined the bank following business college in 1940. When the men came back from the war she was relieved to 'go back to being a lady again'. She was promoted to manager's typist and enjoyed his kindly protection. 'It was like a family in the branches. I was well looked after . . . the manager's wife taught me to drive'. After nine years, Jane was moved to the women's section, Staff Department, which was responsible for women's recruitment, annual reports, probationers' reports and troublesome people. Because she enjoyed this work, she didn't move into the advanced appointments scheme until 1969, twelve months after it had been introduced. She felt it was like 'being approved to be a man' but eventually did take up an appointment in the savings bank head office.

Jane lives alone, and has never married, a matter of some regret. She thinks the married girls have it really sewn up. They can combine work with stimulation at home and they have no financial worries; 'I don't mean the one's with children'. She has a lot of women friends in the bank who, like herself, are single. 'We were all born too early. . . . It was gloves and hat when I started, but now things have changed a lot and women are more accepted'. Somewhat ruefully she commented:

> Some women are able to be one of the boys. I haven't done that, I've made it without doing that . . . I'm not ambitious . . . I always waited to see where the bank put me . . . I have to admit I miss my boss.

Branch manager

Elizabeth learned a lot about loans work as a result of many years as a loans manager's secretary. She was thus able to circumvent the usual difficulties women have in getting this kind of experience and eventually became an assistant loans manager. From that she moved to her current position. As a manager she is proud of her lending abilities—lending had gone up since she has been at the branch and she has good relations with local businesses. Many people, especially women, are glad to see a lady manager. Her solidly middle class background and manner are in contrast to the working class origins of many of the others. It puts her at ease in talking to customers and in handling such matters as property evaluations. Her style is quietly authoritative, while at the same time she takes care to make the men around her feel secure. 'It is up to the women to use tact and discretion over promotion. You can't come in with hobnailed boots. Some have, and have ruined their images'.

Elizabeth has never married, and has maintained close relationships with her family, living with them, and looking after them in illness. But her two worlds are kept quite separate.

Ex-branch manager

Robyn grew up in a country town and did a secretarial course when she left school. The branch manager was a family friend so the bank seemed a suitable place for her. This was 1945. After her application had been accepted management said they were sorry they'd taken her on because the boys were coming back and would need jobs. She was told to regard herself as a temporary. She is still there.

Robyn started as a junior, then progressed to typing with some ledger work, both pre- and post-ledger machines. As a typist she gained a lot of experience. Managers and accountants came to rely on her for information as to how the branch operated and about the bank's clientele. She took on a number of relieving positions before being appointed general hand but it was 27 years before she was regarded as a 'reasonable risk' to be promoted to accountant, assistant manager, and eventually manager of a prestigious city branch dealing mainly with business people. She has since been transferred to head office where she manages a contributory mortgage investment scheme. She misses the customer contact of branch work, but rationalises that: 'with machines you don't get it anyway'. The reason for her transfer is not clear, but on the face of it it looks like an example of a woman being 'kicked upstairs'. She thinks that the bank is no longer appointing women as branch managers.

These three women are typical of the old school. They did not have careers in mind when they first joined the bank. It was taken for granted that they would work until marriage and they then just 'stuck around for a long time'. All the women in senior positions we spoke to have either remained single or married late in life thus escaping the marriage bar. As typists and secretaries to men in senior positions they gained experience and knowledge, which helped them move once the career ladder was opened to women. Many grew up in the country where banking was one of the few prestigious, respectable jobs available:

> It was acceptable to my parents who would otherwise have kept me at home being a lady. (A branch manager)

What these women have to say about making it in a man's world is also interesting. They all think that women have to be careful not to push themselves to much, or they will ruin their images. Men will be threatened by women who do not retain their femininity. The section officer who felt that the bank was 'like a family' and now 'misses her boss' is a lovely example of the success of the banks' paternalistic form of control. On the other hand, most younger women prefer the more bureaucratic forms of control which have replaced this. A woman who is now an officer-in-charge in EDP and ten years younger than Jane had this to say:

> You can see what you are working towards, and given some luck, being in the right place at the right time, you will get there. You can use the bureaucratic structure, it is less chancy. You can also see your own assessments, and have more chance of making a realistic assessment of your own capabilities. I don't think there is much discrimination in EDP. If you have ability they're quite happy to exploit it, whatever your sex. So you have to take the bit by the teeth and see how you can make the most of it for yourself too.

Another group of senior women in banks are young technocrats who have not made their way up through the career ladder but have come in as part of a new policy of recruiting graduates. Such horizontal recruitment is likely to increase as the career ladder disappears; middle class men and women will be recruited for management positions.

Some women who went into banks about ten years ago have worked their way through to junior management positions. This was the period when the banks began to actively recruit women, and offer them the opportunity of a career. Here are some representative cases of the atypical few who have made it to career grades.

Accountant

Helen is a bright working class woman who joined the bank to please her mother, although she had wanted to go to university. She managed to avoid telling, a job which she regards as boring and unpleasant and moved quickly into examining. She has been in her current position for six years now and will need lending experience to get any further. Certainly she wants to move on; she claims that she's becoming 'part of the furniture'. Work makes her feel 'alive' and 'a real person'—she would hate to be at home all day. Helen was married briefly but now regards it as a bit of a mistake and sardonically views children as disastrous for women's lives. She discourages her own female staff from marriage—says that like herself they'll realise how bad it is and then have difficulties getting back into the workforce.

Accountant

Ruth is in her early 30s and is single. She has only just been appointed to this position although she had been relieving as an accountant for five years. She joined the bank twelve years ago via Centacom and regarded it as just another workplace. She still sees it as 'just a job'. 'Mind you most men of my age are managers—I'm even older than the manager here.' Ruth thinks the only reason she got promoted was because she is single. She knows good securities clerks with more experience who have not been promoted because they are married. Still, it is better to be in the bank—'outside I'd only be a typist'.

Secretary—staff club

Sandra is a working-class woman who started as a data processing machinist in 1972 and moved quite quickly through the all-female areas of EDP into a male area of EDP and now manages the staff club. Before the bank she worked for three and a half years in an insurance company doing clerical work and computer input. She left to go overseas and when she came back worked for six months as a cashier in Coles Supermarket. She has left the bank a couple of times to travel. After two years of machining she had become a supervisor; on returning from an overseas trip she went back into input/output, working shifts 'which wreck you'. She wanted to get out of production, and managed it. Her first appointment was in the chief manager's office, EDP. In her current position she has four women under her. The staff club handles staff discounts, theatre bookings, film processing, and travel. Although she hates the idea, she believes it is very important to have a male patron. 'You don't get anywhere unless there is someone up there pushing you when the opportunities come.'

These are all cases of working-class women who have experienced some upward mobility. But this is limited and, as Ruth in particular is aware, the status of management is questionable. Accountants are essentially supervisors, and as the role of branches is further downgraded, the status of most branch managers will also decline. With branch rationalisation their numbers will drop. There is very little opportunity for these women to move further up the ladder. Sandra is even more atypical than the accountants. Production areas in date processing are regarded as quite separate from the rest of the bank workforce, and apart from the rare exception, women never move out of them. It is worth noting again that none of these women is married. Other women we spoke to confirmed the view that management prefer single women.

What do women coming into banks now think about their job prospects? We sat in on an induction course for a group of about eight women. The one bloke who was meant to be there hadn't shown up. These young women were straight from school, and all of them lived in Sydney's western suburbs. They had been actively looking for jobs since about May of their HSC year. In answer to why did you choose banking they said that they did not choose. A couple of them had applied for apprenticeships with no success. They saw their job options as banking or the public service, with a preference for the latter. Their image of banking work: 'it's just clerical'. None see themselves as staying more than a couple of years. They want to use it as a way of getting into something more interesting. But if things went well they would consider staying to become accountants. They had been told about career possibilities in their initial interviews.

A continuing sexual division of labour

The opening up of the career structure to women, and formal equality of opportunity, have not led to a breaking down of the sexual division of labour. This division of labour has been maintained and extended. It has played a critical role in the gradual dismantling of the career structure.

Telling

Telling was once a prestigious job. Tellers had to be over 21, were usually 24–25, and had already worked in the bank for several years. It was the first step on the career ladder for young men. Now young people are moved quickly into telling with minimal knowledge of banking processes. The number of women on the counters has dramatically increased. However, women usually start on machines in the back office where most of them stay; whereas men move more quickly into telling and, with rare exceptions, never operate machines. It is a common complaint amongst the women that men are put on telling much earlier. A girl in one branch we visited had just been put on telling after two years whereas the boys went on after five months. Over and over again we have been told that girls pick things up more quickly, are more mature, and better tellers than boys. They know what they're doing because of the time spent in the back office. Because the blokes are hopeless they are quickly promoted off the telling line. 'Boys in banks look tatty, they don't even clean their shoes', said one female accountant. An administrator commented, 'Except with their mothers, they're hopeless. They don't know how to talk to customers, and they're immature, especially the Australian ones'.

The movement of women into telling is significant given the future prospects for this area of bank work. The major trend now is towards discouragement of personal transactions and services to the public. Automatic tellers will increasingly fulfil many of these functions—and for the remainder, customers are expected to queue up. Telling is now substantially keyboard work, as the details of transactions are punched directly into the computer. As happened previously with the ledger machines, women have moved into an area as it has become mechanised and the number of staff required are being drastically reduced.

The back office

In the back office junior clerical and machining work is almost exclusively performed by women. Ledger machinists have been replaced by 'input operators' and the work involves 'punching' or 'inputting' rather than 'posting'. Before the work is punched into the terminal it has to be proved or sorted and 'batching' is the term used for this. Operating machines is regarded as tedious work which the men are reluctant to do. It is generally believed that girls are better at detailed work, and that boys are more slapdash, and lack concentration on the machines. Women have greater manual dexterity and, given a routine, are less likely to depart from it. Sometimes it is acknowledged that women too get dissatisfied but this is resolved by moving them from one machine to another.

The other areas of back office work are examining and supervision. Examining, since computerisation, has become much more mundane, with minimal decision making involved. It is now done by both men and women. With the work process rationalised via machines, supervision has become less crucial and women hold a larger proportion of supervisory positions. Increasingly it is women that they are supervising—women on keyboard and machining work. We found that female supervisors frequently felt they were not getting their due. One, who had been with the bank for thirteen years, had been relieving classified officers for two years and has yet to receive a classified position herself. She felt that a man would have got this much earlier and that a woman had to work twice as hard to get recognition. (The assistant manager confirmed that he regarded her as his 'right hand', capable of any job in the bank.) Another senior woman put it more strongly. She felt there was almost a conspiracy against women. Not only were they not encouraged but those who did make it were denied further promotion. She cited cases of women who she felt had been 'kicked upstairs', pushed into deadend jobs.

The EDP centres

The work on machines and terminals done by batch clerks, savings bank clerks and input operators is probably best understood as part of an overall process, most of which takes place in EDP centres. The work now revolves around what happens in the centres rather than the branches.

The employment pattern in EDP centres throws some light on likely overall trends in banking, despite the fact that the numbers are relatively small. In a sense this is the whole point. Branches have the employment numbers; they need to be reduced. EDP has comparatively few and it does most of the work. It is treated as a relatively separate area, and recruitment has been on quite a different basis. People are employed for specific jobs and there is little mobility between different sections. The workforce is divided between the few highly paid jobs (systems analysts, programmers) and a larger number of routine jobs (machine operators, process workers). The latter area of work is described by management as 'the factory' and is staffed entirely by women. In chapter four we discuss in detail the sexual division of labour in data processing.

The main activity is clearance operations. As the computer runs 24 hours a day, this work is performed in shifts, the night shift consisting almost exclusively of married women, many of whom are migrants. These new jobs created by EDP have been hailed as offering women job opportunities. Yet if deskilling and degradation apply anywhere in the banks it is here. The women work under assembly-line conditions, with no possibility of advancement. Health problems are common, with regular complaints about colds, bronchitis, sinus, back and neck aches, eye strain, and an iritating itch from the machine area and stationery. We should perhaps be more cautious in using the term deskilled to describe this work. It does not take account of the skills required to cope with these job conditions and, furthermore, accuracy in punching is extremely important. Deskilled or not, these jobs are about to disappear. New proofing machines which are sixty times faster than the 'old' ones are being introduced. In this sense at least, the situation is similar to that in manufacturing.

Recruitment policy varies from bank to bank in the area of EDP. In most cases specialists, particularly analysts, were initially recruited from the bank. The reasons for this were the importance of loyalty to the bank and problems with breaking management resistance to computerisation. Analysts are in a strategic position as far as knowledge of the banking system goes. They, along with other specialists, have been paid the industry equivalent, rather than on the banks' scales, in order to attract and keep them. There is now a trend to recruit horizontally, that is, to employ experts from outside.

Programming is a very competitive area. Many people go into branches hoping to get into programming; bank computers are attractive because they are so big. We came across women in this situation who had experienced considerable difficulties: delays in starting training, being given clerical work during training, and at times sexual harrassment. Sometimes they decide that branch work is preferable because women are treated better there. In summary, EDP has meant displacement of clerical positions in the branches. A new labour process has been created and a new job hierarchy set up, the most distinctive feature of which is the 'factory area' staffed by women.

Banking on the 'girls'

Bank work has become increasingly routinised and repetitive. The term deskilling could be applied in relation to changes in the content of 'mental' labour. Whereas in manufacturing it refers to the loss of knowledge and control associated with a combination of mental and manual skills, in white collar work such as banking it refers to a loss of knowledge of banking processes as a result of fragmentation. If it is used in this sense, then it is also middle class people, such as branch managers, who are experiencing a deskilling of their work. A woman who has been in the bank for forty years put it like this:

> I haven't been *opposed* to computers. . . . Some men and women accept that one no longer has complete knowledge of the job . . . it is no longer possible to be an expert. There was once a time when there was very little that I didn't know.

There is now very little opportunity to move up the scale. The career structure has been gradually undermined and it is more than likely that management will abandon it completely in the near future. It is considered to be unwieldy and clearly its usefulness as a controlling ideology is wearing out. In its place a tiered structure is likely to be introduced. People will be recruited and paid for specific jobs from which there will be little opportunity to move. The Bank of New South

Wales (Westpac) introduced a two-tier structure in December 1981: operational (School Certificate) and career (HSC). Sixty per cent of operations recruits are female. This bank is also recruiting graduates for future executive needs. Although some women will make it into the career strand, and female graduates are being recruited, this is linked to a relative shortage of male applicants. The bottom tier will be almost exclusively female. Women will again be formally locked into the lowest positions. The only exceptions will be tertiary educated, middle-class women.

The career structure was opened up to women at the very same time that it began to be dismantled. By increasing the proportions of women in the industry this process was obscured. Some career opportunities remained for the men, while women did the bulk of the low level work. Thus it could still appear that banking was a career industry offering upward mobility. Men could measure their career success against the work that women performed. As in the case of whitegoods, masculinity is potentially threatened; this time the middle-class masculinity associated with having a career. Again it is retained by virtue of the sexual division of labour. Loss of jobs at all levels could also be covered by natural wastage with women leaving at an early age. Given the current economic situation and the need for two incomes, they are less likely to leave now. With rationalisation and branch closures, sackings can be expected in the not too distant future.

As with whitegoods, this has not been a smooth process. Changes in the labour process took place under the guise of opening up job opportunities for women. Many women have become conscious of the fact that equal opportunities have been held out to them and yet men advance more quickly. They are angry about young inexperienced men moving ahead of them, and are aware that their capabilities are not being fully recognised or rewarded. Many have experienced hostility from men in the course of promotions. One of the ways in which women resolve this conflict is by participating in a redefinition of the gender of bank work. They will frequently say that they would not allow a son to go into banking. The women on the training course told us that it was seen as 'poofy'. Bank work is now women's work.

To return to the original sociological dilemma: most jobs in banks, as in other offices, can now be considered working class in that they are routine, repetitive, require and allow little knowledge of the overall process, and movement into management is restricted. Changes in the nature of bank work have been paralleled by a feminisation of the workforce. However, sociologists who attribute a division between white collar workers and blue collar workers to feminisation of white collar work are mistaken. In these accounts white collar work is defined as middle class because it is done by women, whose class position is defined either in terms of consciousness, or husband's class position. If the mental/manual distinction is continuing despite objective changes in the nature of mental labour it is because men in these white collar industries engage in 'mental' labour and make it into the middle class. The majority of women remain in 'manual' jobs. Whatever their consciousness, women occupy the newly created working class positions.

This is not to evade the question of industrial consciousness of white collar workers but rather to point out that any lack of militancy can not be attributed to some inherent conservatism of women. It is difficult and possibly dangerous to try and generalise about the trade union consciousness of bank workers. When asked 'would you attend union meetings', most of the women we spoke to demonstrated a lack of interest in the union. Yet it is not so much hostility as a belief that 'it doesn't do anything for us', or 'it is only concerned with trivia', or they displace responsibility by saying that 'bankies aren't interested', 'no-one goes on strike'. A trainee programmer who had been to union meetings didn't think the union was strong enough, but doesn't like militant unions. Some of the women who have now 'made it' were involved in the Women's Advisory Council, formed in the mid 60s to advise the CBOA on women's rights. Most of the women we spoke to are conscious of discrimination even if they don't see the union as the appropriate means for combatting it. The young women who described bank work as 'just clerical work', began by saying they wouldn't go to a union meeting, then said they would if they were going to lose their jobs or to gain an extra day's holiday or a pay rise.

Militant industrial consciousness is very seldom generated spontaneously. The bank unions, the CBOA and the Australian Bank Employees Union (ABEU), are militant as far as white collar unions go and have adopted a militant approach to technology and job loss. Yet they tend to accept the view that bankies are difficult to organise, and that women are particularly conservative. Our analysis of the position of women in the banks points to an alternative conclusion: women are less likely than men to accept the ideology of upward mobility, or the mystification of machines and ideology of progress that the banks have been using in their counter union compaigns.

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3

High technology, employment and the challenges to education

Richard Gordon & Linda M. Kimball

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The contribution of employment in high technology industry to future employment growth in the US economy is estimated to be small. Much high technology employment is not professional work at all, but routine labour, and much of that performed by minority groups with few career opportunities. Most new jobs will occur in occupations requiring no more than secondary education. High technology may generate employment in other areas, but often low grade work performed in the "homework economy". Appropriate education for employment in high technology industry and in computer-related fields is not necessarily specialised and technical; high-quality general education is probably more important. Instrumental education, ignorant of the demands of high technology, and of the demands a modern economy makes upon high technology, is likely to be counter-productive. Commercial and technical success requires a combination of cultural learning and technical skill.

Keywords: high technology, education, employment, electronics, computers, Silicon Valley

INTRODUCTION

Job creation can take a number of forms. Changes in processes, products or markets may generate entirely new forms of enterprise and new occupations or jobs. Economic and organisational expansion, or changes in occupational structure, can multiply (or contract) the number of positions within existing sectors of employment. Work requirements and skills might be transformed to such an extent that traditional jobs effectively become accessible to new types of worker. Since microelectronics and computer-based technologies have such profound and simultaneous impacts upon factors affecting employment (price/performance characteristics, product design, production methods, organisational structure, locational flexibility, firm size, productivity, labour demand), job creation and the nature of work in the contemporary era appear particularly dependent upon the social advance of high technology.

Because high technology's impact upon employment opportunities, occupational structure and skill requirements is mediated by its knowledge-intensive character, the information economy ostensibly presupposes new strategies of labour formation. New forms of scientific and engineering professionalism will be required to sustain high technology development. Large segments of the labour force will require extensive training, or retraining, in computer-related skills. Computer-based technologies will impose more sophisticated skill requirements on individual jobs and will shift the distribution of employment in favor of more advanced worker capabilities. Preparation for labour market entry will assume a background of familiarity with computer equipment and technological culture.

It is a common presumption that rapidly changing labour force requirements resulting from the application of new technologies have outflanked and undermined both the structure and content of existing education at all levels, a disjuncture that is all the more serious as information is converted into a commodity and knowledge becomes a strategic resource. Impelled by this sense of crisis, far-reaching educational reforms have been proposed in the United States and elsewhere. These programs simultaneously enhance the social importance of education while advancing its subordination to technological imperatives.

The present analysis examines the relationship between high technology and employment creation with specific emphasis upon aggregate employment levels, occupational structure and skill requirements, and the challenges confronting educational policy in advanced industrial societies. The first two sections present new evidence regarding employment generation and occupational structure within high technology industry itself and critically assess the industry's reputation as a model of knowledge-intensive job growth. Similar ambiguities concerning the general economic significance of computer-related occupations are delineated in the third section of the paper. The near universal tendency to extrapolate high technology's impact upon social employment from technical attributes alone is examined in the following section, where it is suggested that a prior determination of changes in the fundamental nature of work must precede any assessment of aggregate employment effects. In the fifth section it is argued that, while computerisation is **technically** compatible with a wide variety of skills, **social** constraints imbedded in the logic of deployment of computer-based technologies render certain skill configurations more efficient and productive than others. Finally, several contradictions inherent in prevailing assumptions about educational strategy for high technology employment are examined and proposals are made for transcending the limitations inherent in the equally vulnerable claims of technical and general education.

EMPLOYMENT CREATION IN HIGH TECHNOLOGY INDUSTRIES

Substantial labour displacement has occurred within traditional manufacturing and service industries subject to international competition, declining profitability, disinvestment and rationalisation. High technology industries are invariably represented as counter instances of employment generation in the information age. Job creation in high technology and related sectors is expected to compensate for job loss in other areas. Analysis of high technology employment in the US, the global center of expansion in electronics, provides a critical insight into the effectiveness of these compensatory mechanisms.

Definitions of high technology industry vary considerably. Some conceptions are too narrow, allowing one segment of electronics (usually semiconductor manufacturing) to represent the entire industry. Others are too broad, including standard manufacturing industries that are neither 'emerging' nor 'knowledge-based'. High technology refers here to enterprises engaged in research, development, design or manufacture of electronic products or computer-related services. This sector tends to have high ratios of research and development (R&D) investment to sales, and high percentages of scientific and technical personnel. It also involves considerable proportions of standardised manufacturing and routine labour. In terms of the US Standard Industrial Classification (SIC) System the high technology sector incorporates electronic computing and peripheral equipment (SIC 3573); telephone and telegraph apparatus, radio and television broadcasting, communication and signaling equipment (SIC 366); semiconductors, electronic devices and components (SIC 367); guided missiles and space vehicles (SIC 376); engineering and scientific instruments, measuring and controlling devices, optical instruments (SIC 381-383); and computer software and data processing services (SIC 737).

The most recent data reveal that each sector of the electronics industry has exhibited steady, sometimes spectacular long-term employment gains over the last two decades, though employment levels have been subject to sharp fluctuations and gains have been more substantial in semiconductors, computers and software than in other high technology sectors. By 1984, the domestic US high technology industry as a whole employed 2.73 million workers, an aggregate increase since 1965 of 182 per cent (compared with an increase in total US employment over the same period of 53 per cent).

This impressive growth record is mitigated in three different ways. First, electronics employment represents only 12 per cent of all jobs in US manufacturing and less than 3 per cent of total US non-agricultural employment. High technology is dwarfed by other economic sectors (employing one-sixth of the number of workers on government payrolls for example). Second, the future of global electronics competition, and thus of future employment impacts, is uncertain. While underlying trends, contrary to superficial appearance, appear to favor the US electronics industry against its Japanese and European rivals, it is more doubtful that recovery will produce the same level of sustained employment increase as in the past. Annual rates of labour force growth in 1975-1979 were more than twice the rates of increase over the 1980-1984 period. Third, though high technology industries will continue to expand more rapidly than total employment, they are expected to contribute less than 9 per cent of all new jobs in the period of 1982-1995.

Thus, all but a small proportion of the new jobs created in the foreseeable future will originate outside high technology industry.

High technology industry's contribution to overall job creation in the economy is relatively small and the future expansion of the industry is likely to have little impact on reducing current levels of unemployment.

OCCUPATIONAL STRUCTURE IN HIGH TECHNOLOGY INDUSTRY

If high technology industry is an example of the positive relationship between technological innovation and job creation, it is also extolled for its embodiment of new forms of 'knowledge-intensive' labour. The industry's development ostensibly offers strong support for the view that an economy based upon new technology will generate net employment growth and produce jobs with higher average levels of skill and responsibility.

Comparative analysis of different US regional high technology complexes reveals that the production workforce typically comprises between one-third and one-half of total employment (compared with two-thirds or more of all workers in traditional manufacturing). Moreover, the industry has evinced a consistent increase in the proportion of scientific and professional employment over the past two decades (though this varies by sector). The decline in the relative share of the production labour force has been especially severe between 1980 and 1984. Projections for the growth of 'knowledge-intensive' occupations, therefore, find support in the increasing percentage of non-production workers within the expanding employment base of the electronics industry.

This model fails to register, however, either the existence of the remaining production labour force or the typical segmentation of occupations within electronics. Somewhat paradoxically, high technology industry generates a high proportion of traditional routine jobs, even restoring Taylorist forms of work organisation at the same time as they are receding in many other industries. Contrary to common belief, a major portion of jobs within information industries are not knowledge-intensive.

The high technology labour force is divided between a stratum of highly paid professional, scientific and technical employees and unskilled/semi-skilled production workers, usually non-unionised, performing routine tasks (sometimes in hazardous conditions) at comparatively low wages. The basic dividing line separating the two groups is educational: one set of jobs requiring advanced levels of educational achievement and specialised qualifications, the other requiring primarily basic aptitudes and positive work attitudes. Little mobility exists between the two segments.

Compounding the educational divide within the US electronics labour force is an equally fundamental stratification based upon gender and ethnicity. As the hierarchy of skill, status and income ascends within high technology, positions are increasingly occupied by white Anglo males. In Silicon Valley, for example, white males comprise a relatively small percentage of production workers (23 per cent), but predominate in technical positions (55 per cent) and professional (scientific, engineering and managerial) occupations (72 per cent). Conversely, female and ethnic minority workers cluster in less skilled jobs at the lowest level of the occupational ladder.

Together they comprise 28 per cent of professional employees, 45 per cent of technical workers (these figures weighted by a large number of immigrant male Asian employees), and 77 per cent of production workers. Recent detailed research indicates, in addition, that women and minorities tend to cluster within specific job categories, within specific types of firms and within specific sectors of the industry, and that this clustering imposes severe obstacles to career mobility. Thus, in spheres where women and minorities tend to be employed, possibilities for entering more highly qualified positions are restricted; where career opportunities are more plentiful, few women and minorities tend to be employed.

COMPUTER-RELATED OCCUPATIONS

At one remove from employment in high technology industry itself, and overlapping with it, are occupations directly related to the application and use of computer technology (installation, programming, processing, operation, and servicing). Recent projections confirm the explosive rate of job creation in this area: computer-related occupations comprise four of the top five (and five of the top ten) fastest-growing employment fields in the US between 1982-1995.

High rates of job growth, however, do not translate into high levels of aggregate employment. The five principal computer-related occupations will provide only 2.6 per cent of total projected employment growth in 1982-1995. Some computer-related occupations show negligible growth and others are declining. Not a single high technology or computer-related occupation appears among the twenty occupations projected to experience the greatest employment growth in the next decade and a half. The five largest growing employment sectors, providing more than five times as many new jobs as the top five computer-related occupations, are all characterised by relatively low skill requirements. Only two of the ten largest growing occupations (collectively providing 25 per cent of all new jobs in 1982-1985) require post-secondary education.

In sum, rapidly expanding high technology and computer-related jobs will make a small contribution to overall job creation. Numerically, the most significant new employment gains will occur in occupations requiring secondary education or less.

HIGH TECHNOLOGY AND AGGREGATE SOCIAL EMPLOYMENT

Analysis of the impact of high technology innovation upon general levels of social employment has become a field of vast oversimplification in which both optimistic and dire projections tend to employ flimsy economic evidence, narrow and misleading projections, and a lack of concern for qualitative, in addition to quantitative, change. Many aggregate studies forecast adverse employment impacts while assuming constant levels of productivity or omitting consideration of factors potentially offsetting job loss. Other studies base their optimistic calculations concerning employment increase on unrealistic or purely speculative estimates of price movements, sales volume or economic growth. Strictly speaking, the kind of data necessary for an assessment of the aggregate employment impacts of high technology is lacking; existing projections remain quite conjectural. This problem is compounded by the fact that, far from being mutually exclusive alternatives, quite divergent outcomes — employment increase and labour displacement — occur simultaneously.

Technological change is not necessarily correlated with declining labour demand. Historically, the cumulative impact of previous industrial revolutions has expanded available jobs roughly in parallel with the increase in active population. After World War II, technological innovation, productivity increase and employment expansion were compatible. With high technology, new industries are created, new products and services are generated, costs are lowered and demand stimulated. Traditional sectors may continue to grow despite computerisation. Application of computer-based technologies may require additional employment, even when introduced for 'labour-saving' purposes. Job loss resulting from delayed innovation or loss of international competitiveness may outweigh labour displacement issuing from automation.

On the other hand, abundant evidence suggests that the information revolution engenders job loss. Opposition to increasing state employment and prospective automation indicates that the tertiary sector may replicate the 'jobless growth' pattern of the primary and secondary sectors, thus removing the final barrier to pervasive structural unemployment. Examples of widespread job destruction are abundant in factories and offices. The disjuncture between traditional skills and those associated with computer-mediated work creates permanent unemployment for those made redundant in older industries.

Contemporary experience, therefore, suggests a wide range of possible simultaneous outcomes varying according to sector and to circumstances with regard to high technology's employment impacts: job displacement, declining employment per unit of output counterbalanced by output growth, jobless growth, direct employment increase. Overall economic trends, too uncertain to predict, will prove more influential in future employment outcomes. More importantly, preoccupation with the question of aggregate employment levels has tended to obscure even more significant transformations in the very nature of employment and the organisation of labour: changes in the concept of work, in the identity and character of those performing it, and in its location.

Four forms of labour are particularly important in considering the changing structure, content and location of work in an information society: outwork, part-time employment (permanent temporary work), labour in foreign production sites (temporary permanent employment) and self-service/informal work. These labour markets have quite independent histories and their dynamics remain quite specific in many respects. But they also have a number of features in common: (1) they comprise the most rapidly growing sectors of employment in advanced industrial economies, (2) high technology has reinvigorated each, and will continue to do so, (3) through high technology, these labour markets are connected on a global scale to form a single integrated system, (4) they provide a diverse range of skills, but most labour in these sectors is low-skilled, poorly paid, unorganised, and lacking employment benefits and job security, and

(5) the 'homework economy', formed by the intersection of these labour markets, has become a significant mechanism for articulating growing female labour supply with the production process.

Significant employment growth, directly influenced by high technology but lying outside official statistics or national territorial boundaries, is concealed within the homework economy. High technology, therefore, is likely to generate considerable employment in the future, but, like previous industrial revolutions, it will completely transform the way in which work is done, the kind of people who do it and its location. Unlike the benevolent image presented by the 'electronic cottage', the homework economy does not embody work that is more autonomous, highly skilled and well paid, but, in the majority of instances, just the reverse.

HIGH TECHNOLOGY AND SKILLS

Most studies of high technology and the qualitative nature of work tend to deduce changes in skills, tasks and worker activity from the technical attributes and operational routines of computer-based technology. Two standard perspectives can be derived from such a logic: (1) the embodiment of human functions in computer-based technology marginalises the worker, reducing decision-making and control functions, fragmenting tasks and decreasing the knowledge and skill required of the worker; (2) new technology frees workers from machine rhythms, replaces muscular strength by symbol manipulation, increases decision-making abilities and necessitates higher levels of skill and responsibility. Both orientations capture a portion of reality, but each is unable to provide a coherent explanation of the impact of automation on skill requirements.

Computerisation can be implemented in ways that directly decrease the skill content of jobs. Indeed, the deskilling ramifications of programmable automation are not limited to production or clerical workers, but include highly qualified managerial and professional workers as well. Similarly, workers' skills can be augmented with the introduction of programmable automation. More subtle changes are also possible. For example, when robots eliminate workers at the lowest grades of skill, they correspondingly raise the average skill level of the remaining labour force. When less-experienced workers are trained up to a deskilled job, requalification occurs for the worker, if not for the task itself. Demand for different types and levels of skill may develop simultaneously and in complex combinations. In fact, the precise mix of skills produced is not a function of technological capabilities (which are compatible with either deskilling or requalification), but of prevailing social theories and practices of management, work and production.

Computer-based technologies are not simply ensembles of technical attributes. The operating principles of the computer often are an incomplete guide to the way it is actually imbedded and utilised within differing organisational contexts. The system cannot be separated from the diverse skills required for its operation, the infrastructural resources required for its maintenance and development, and the values and goals of competing, often conflicting, groups regarding its appropriate design and use. In these and other ways it can be seen that computer-based technologies are equally dependent, in addition to their technical character, on the social arrangements in which they operate. The 'web of computing' (Kling & Scacchi) — the specific network of people, resources, services and organisational structure which mediates computer use — is an inherent component of the system. Computerisation is a form of social organisation.

The constraints imbedded in the social character of new technology are particularly manifest in mature forms of integrated automation (CAD/CAM, FMS, DDS) which permit a reconciliation of organisational goals of flexibility and efficiency. Regardless of their impact on the skill content of particular tasks, the gap between the logic imbedded in the design and managerial logic of such systems and the logic of actual systems operation renders them inherently contradictory: (1) integrated systems are governed in fact not by cybernetic feedback and regulation but by contingency; (2) work with computer-based technologies involves a change in the meaning of skill from the concrete mastery of specific tasks to a combination of formal and informal knowledge about the technical and social organisation of production; (3) such systems tend to reintegrate the production processes as a whole for the workers operating them.

The social character of technologically-integrated labour exhibits a fundamental contrast between the level of worker involvement anticipated by systems designers or managers and the extent of worker intervention actually required to maintain and to operate sophisticated automated systems. Paradoxically (and precisely as a function of the manifest inability to reduce social attributes to technical characteristics), systems designed to ensure predictability discover uncertainty as their basic principle of activity, and systems implemented to reduce or to eliminate labour depend for their efficient operation upon the high quality of extensive human intervention.

HIGH TECHNOLOGY, EMPLOYMENT AND EDUCATION

The rapidity and breadth of employment changes associated with high technology generates new challenges for education. Current policy analysis indicates a number of specific problem areas in the education system's adjustment to high technology's impacts. High technology industry and manufacturing or service organisations utilising computer systems are confronted with shortages of electrical/electronics engineers, computer professionals and technical workers. Large segments of the labour force have (or will) become 'information workers' involved in the production, manipulation or distribution of information goods and services, and will require new forms of technical and work-related education to equip them with the requisite levels of skill. Training programs must be retooled to provide new skills on a sufficient scale and substantial retraining efforts will have to be mounted for workers in older sectors whose skills have become obsolete. Finally, as computer-based technology becomes the essential medium for the transactions of everyday life, computer literacy, as well as basic scientific and mathematical skills, will be regarded as essential to informed active citizenship.

Technological change has outdistanced the traditional structure and forms of education: reform is necessary in both general and vocational education and at all levels of the system from institutions of higher learning to primary schools. Collectively these reforms demand a substantial reorganisation of the educational system to meet the immediate and long-term needs of the information economy. Both the need and the prospects for educational reform are exacerbated by the contemporary crisis of US science-based education which threatens the future development of high technology industry and potentially undermines US global industrial competitiveness and defence.

Educational reforms are undoubtedly required to service the needs of the information economy at all levels from the provision of greater numbers of trained engineers and scientists to the inculcation of elementary computer literacy. But these reforms must be carefully situated within broader perspectives which tend to be absent from the existing policy debate. Current proposals, especially those postulating that the education system attune itself more directly and more completely to changes in work practices and employment structure resulting from technological innovation, constitute potentially destructive over-reactions. They both underestimate the importance of other types of educational reform and, even more significantly, seriously miscalculate the educational implications of high technology itself.

First, temporary imbalances have been mistaken for structural misalignments. Specialist skill shortages in electronics and computer-related fields, for example, owe more to the unanticipated pace of industrial development in electronics than to any long-term inability of the education system to respond. Recent evidence indicates that the supply of electrical engineering graduates now meets demand and that increasing enrolments already threaten to create an oversupply. Though naturally lagging further behind, similar responses are occurring in computer engineering and computer science. Moreover, since the electronics industry operates on a global scale, labour demand can be satisfied in part in national and international labour markets.

Second, some structural imbalances have been treated misleadingly as temporary misalignments. Vocational programs focusing on narrow skills training frequently have been inadequate in matching traditional industrial needs, and promise to be still more unresponsive in the future as skill requirements change more rapidly. Vocational programs, therefore, cannot be applied to employment and training needs without substantial internal reformulation of their structure and goals. The same strictures apply to most retraining programs that ignore the social context and purposes of skill displacement and acquisition.

Third, policies for instrumental change, which erode the traditional distance between educational institutions and private enterprise, tend to be self-defeating. Thus, as professional science and engineering departments increasingly adopt purely industrial perspectives and abandon traditional educational values and purposes, they are weakened significantly by competition from industry itself. Academics desert universities for higher salaries in private industry or government research. Workloads increase intolerably for the remaining staff. The quality of equipment and research declines. Industrial absorption of new graduates leads to shortages of students with advanced degrees and threatens the further renewal of departments, perpetuating the pattern of crisis and withdrawal. Similar shortages arise, for the same reasons and with the same results, in secondary education. (Ironically, though not surprisingly, this crisis is especially severe in California and Massachusetts, the national centres of high technology development.) Far more than the temporary shortages which prompted the change, it is precisely the realignment of education in the pursuit of meeting instrumental economic objectives which in fact threatens the long-term quality of scientific and engineering research and development in the US.

Fourth, the assumed links among technology, employment and education, which underlie the proposals for educational reform, have been broken precisely by high technology innovation. It is widely assumed that technological change increases skill requirements within occupations and expands the proportion of higher skilled positions relative to low-skill jobs across occupations, thereby elevating the educational requirements for employment throughout the economy. The connection between technological development, educational attainment and upward occupational/social mobility, does continue to pertain for some occupations (including certain high technology professions), though usually reinforced considerably by labour market shortages resulting from unexpected industrial change or from entry barriers imposed by professional associations.

In many other fields, however, the post-war influx into secondary and post-secondary education has generated an oversupply of educated workers for the economy. Consequently, there has been a general inflation of educational requirements for formal employment: educational qualifications for jobs have risen not as a function of expanding skills intrinsic to the work itself, but as a result of relative abundance of over-educated applicants seeking positions.

High technology compounds the increasing discontinuities between education and work. In addition to its employment of higher proportions of scientific and technical labour, the electronics industry has encouraged the formation of substantial numbers of unskilled and semi-skilled manufacturing and clerical jobs. The social organisation of high technology in other sectors is as compatible with downgrading skill (and educational) requirements as it is with the enhancement of educational qualifications. The synthetic capabilities of high technology — its capacity for integrating formerly disparate functions and fields — as well as the increased pace of industrial transformation, creates uncertainty about the long-term viability of all forms of narrow expertise. Scientific and technical skills themselves are no longer immune to dequalification or rapid obsolescence. In all of these respects (and others) high technology demonstrates the fragility of the interrelations between employment and education and the need for a more complex understanding of the educational implications of technological change.

Fifth, the economic impact of high technology should not be exaggerated. Employment within high technology and computer-related fields will not substantially reduce prevailing levels of unemployment. More jobs will continue to be created outside the sphere of high technology and large numbers of jobs will require relatively low skills and educational qualifications. The diffusion of high technology, contrary to oversimplified assumptions, will contribute heavily to the growth of such jobs, particularly in the homework economy and in firms unwilling to alter traditional forms of hierarchical organisation to take advantage of the full range of new possibilities for administrative and work structures opened up by new technology. (Recent studies indicate, for example, that in the US 75 per cent of office automation installations are employed to reinforce disciplinary control over workers and reduce qualifications.) These trends demonstrate a continuing, perhaps even more urgent, need for the reinforcement of high-quality general education and the extension of traditional educational opportunities to still broader segments of the population.

Sixth, high technology should not be the more or less exclusive focus of educational and training policy. The future global competitiveness of the American economy will depend less on the singular success of high technology itself than on the economy's ability to meet international standards in traditional manufacturing (process and product) technology and organisational innovation; that is, on its potential to integrate rationally high technology with existing economic sectors. As much, if not more, attention should therefore be given (a) to reconstructing traditional skills and practices, and (b) to the interface of high technology skills and traditional skills, as to high technology skills themselves.

Seventh, a significant barrier to the reformist educational impact of technological innovation is the prior conformity of high technology to the existing structure of educational inequality based upon class, gender, ethnic background and geographic location. Educational inequality is a principal axis of differentiation within the occupational structure of electronics and the polarisation of the labour force tends to eliminate internal career ladders and preclude the kind of upward mobility associated with traditional manufacturing industry. To the extent that work organisation is recomposed and this polarisation reduced, workers on the bottom of the occupational ladder are either unable to compete for the new positions or are transferred into equally segmented intermediate job categories. Inequalities based upon gender and ethnicity prevail throughout high technology industry: in the industry's occupational structure, in its international division of labour, in the different modes of teaching computer literacy to boys and girls in school, or in the different forms of computer training delivered in inner city and suburban schools.

Although the number of women and minority men awarded degrees in scientific and technical fields is increasing, these strata remain vastly under-represented in the educational channels leading to highly skilled and well-remunerated high technology jobs. The distribution of scientific and technical credentials is also stratified hierarchically in such a way that those who are already under-represented in these fields are increasingly under-represented at advanced levels of academic training. Technical shortages, high labour costs and concomitant advances in computer-aided design have provided the basis for the reorganisation of work responsibilities in the engineering profession: lower status visual and manual skills are being simplified and consigned to those previously excluded; while more abstract engineering skills and highly valued managerial functions continue to be the almost exclusive domain of white Anglo (or Asian) men. Teaching methods and shifting criteria of excellence within engineering education ensure the reproduction of technical inequalities embedding these labour market conditions. Even the much expected democratising effects of using computers in schools have not materialised for the younger generation. Both access to computers and different approaches to using computers in elementary and secondary schools reconstruct traditional inequalities in such a way that power relationships between managers, workers and machines are differentially established in early childhood. In offshore assembly plants and in the homework economy, certain levels of education have been required of workers as a means of ensuring self-discipline, application and low error rates in low wage routine jobs.

Eighth, a final dimension of the relationship between high technology and education concerns an incipient cultural transformation in the very concept of knowledge itself. In its fifth generation form particularly, high technology (artificial intelligence, expert systems) has assumed the ground of knowledge itself; computers have come increasingly to specify culturally the form, possibility and limits of thought. In fact, this claim legitimates the extension of a particular, limited form of rationalistic knowledge throughout all areas of social life. Computers can produce 'knowledge' only within the narrow structure of a precisely articulated framework which imposes upon its users a specific conception of information, organisation and action. Unbreachable structural barriers preclude the simulation of genuine human thought and action in systems utilising artifical intelligence and natural language capabilities. Expert systems should be considered as 'novice systems' precisely incapable of delivering expertise. The design of computer systems must include an understanding of the limits of computerisation and of the necessary linkages between computer systems, their social contexts and the continuing necessity for extensive high quality human intervention in computer-mediated environments.

CONCLUSION

Emphasis upon instrumental adaptation to, and utilisation of, high technology undermines rather than liberates the potential for social and technical change. There is no doubt that the information economy presupposes the expansion of skills concerned with manipulation of the physical world. Scientific and engineering capabilities will become more widespread and receive more cultural prominence. Technical skills for the deployment of computer-based technology have become essential to the completion of a broad range of tasks in modern society. The need for some level of technical qualification as part of normal employment requirements will magnify as capital-intensive flexible production builds upon capacities for process and product specification, rigorous quality control standards and servicing varied end-user requirements. Service workers require knowledge of the functional integration of work tasks, firm operations and computer systems. Minimal standards of computer literacy are becoming a near-universal requirement for individual interaction with major social institutions.

Yet mere conformity to the 'imperatives' of new technology is quite insufficient to resolve the problems attending transformation to a computer-based society. Most importantly, workplace deployment of computer-based technologies increasingly will require abilities to participate in the social organisation of production and administration, which transcend the limits of particular skills resulting from individual technical training or specialised education. Only if workers are experienced with the range of tasks and operations necessary to complete production can they re-arrange the various components efficiently when confronted with the sudden or frequent demands for change inherent in the utilisation of computer-based technologies. Policies which impede this adaptability are inimical to the competitiveness of firms in an integrated world economy. Effective control and decision-making, practical learning and efficient utilisation of new technology reinforce each other: computerisation strategies designed to eliminate or confine such skills perform less productively than structures designed to enhance them. Computer-related jobs, in fact, are oriented to analytical, communication and control functions which require broad familiarity with learning skills, aptitudes for organisation and social interaction and an understanding of the social bases of technological culture. The foundation for individual expertise in this context is the organisational appropriation of the social character of high technology: education and training, therefore, must focus on the control and management of systems as well as the social prerequisites for the effective utilisation of new technologies.

Efficient (non-dysfunctional) deployment of computer-based technologies demands strategies of *social innovation* which will maximise the productive potential of high technology by providing the preconditions for decentralised, integrated work group control of the production process in its entirety and its permanent direction of evolving technological capabilities.

The flexibility of social organisation is central to the developmental possibilities of the technology itself. Paradoxically, the implicit social logic of mature automation is more democratic in its potential than either the forms of centralised work organisation or the instrumental education strategies typically justified in the name of adaptation to the technical requirements of computerisation. The conflict between the self-defeating 'technologisation' of society and the social organisation of technology will provide the framework for the future development of automation.

Instrumental education, ignorant of the social preconditions, character and consequences of new technologies, tends to be counter-productive, adapting people to imaginary or obsolete technical contraints, and invariably promoting second-best (or worse) uses of the technology itself. Yet, a reassertion of traditional educational values does not provide a complete answer to this dilemma. Continued support for classic democratic education remains imperative: cultural creativity across a wide spectrum of achievements (not scientific or technical expertise alone) is fundamental to any humane society and the need for an enlightened and active citizenry is hardly less significant in the information age than it was before. At the same time, traditional education shorn of familiarity with new technologies severs its recipients from vital material components of modern culture and aligns itself with instrumental education's propensity to compound existing inequalities. Ironically, in a context governed overwhelmingly by technological imperatives,the goals of commercial and technical success will best be served by combining cultural learning and technical skill within an education consciously oriented towards democratic social control of technological change.

4

Computer literacy and ideology

D. Noble

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The need for some form of "computer literacy" has come to be accepted as an essential condition of everyday life, now that the computer has insinuated itself into our jobs, our schools, and our homes. As a result, computer-literacy education has become very big business, evidenced by the myriad of computer classes, workshops, and camps available to people of all ages. The purpose of all this training, we are told, is not to make engineers or programmers of everyone; rather, its focus is on a minimal level of instruction that will introduce the masses to the ubiquitous computer and enable them to feel "comfortable," to have "a sense of belonging in a computer-rich society."[1]

Although this goal seems reasonably straightforward, its promoters, while insisting on the critical importance of computer literacy, have had unusual difficulty arriving at a suitable definition. "No one can tell you exactly what it is," writes one promoter, "but everyone is sure that it is good for us."[2] This unexamined conviction, more felt than understood, has somehow triggered a mass educational campaign whose urgent, uncritical endorsement is without precedent in the history of technological education.

This article is in two parts. The first part will show that computer literacy, however it may be defined, is unimportant, despite its plausibility and its fervent promotion. The second part will attempt to explain the enormous appeal of computer literacy despite its unimportance. It will be suggested that the computer-literacy phenomenon might best be viewed not as education, but rather as an ideological campaign, one that coincides with and reinforces a hegemonic vision of a computerized future.

COMPUTER LITERACY FOR AN INFORMATION AGE: MYTH VERSUS REALITY

Arguments that have been used to justify the importance of computer literacy can be reduced to four, each corresponding to a role of daily life in the "information age":

1. Consumers must be computer literate in order to function in the computerized marketplace.

2. Students must be computer literate in order to cope with the computerized "learning revolution" in schools and colleges.
3. Workers must be computer literate in order to survive in the "high-technology" work force.
4. Citizens must be computer literate in order to vote and take an active part in the "information society."

CONSUMER LITERACY

Turning first to the needs of the consumer, we find that while computers are indeed invading the marketplace and the home, there is nothing one has to know about computers in order to function successfully in a world of electronic ovens, "moneymatic" machines, and multifunction watches. "The future," according to one manufacturer, "lies in designing and selling computers that people don't realize are computers at all."[3] Although there may be as many home computers as television sets by the year 2000,[4] this will happen only as they become as easily accessible. Even today the majority of home computers are used exclusively for packaged games;[5] most other home uses, such as budgeting or filing recipes, require little more than inserting a cartridge or disk and following simple directions on a screen.

How then are we to understand the consumer's supposed need to be computer literate? It is of course true that computer enthusiasts need to know how to program and how to find their way through a maze of computer products, but most consumers are not in this category. To purchase or to repair computer products one will be able to turn to knowledgeable friends, salesmen, or technicians, just as consumers today do with their cars and television sets. Although it might be nice to be able to do it all oneself, such dependence in the world of cars and television sets is hardly seen as dysfunctional today, and so it will be with computers tomorrow. In fact, as computers become more standardized, more self-diagnostic, more "user-friendly," such dependence will be far less problematic than that of today's typical car owner.

It is often said that "using computers is going to be just like driving a car,"[6] but given the ease with which a typical teenager learns how to drive, it is difficult to understand why this analogy is offered as an argument for computer literacy. Furthermore, such a skill as driving is best acquired as the need for it arises; similarly, people can learn whatever they need or want to know about computers without having to be prepared or "literate" beforehand. The idea of computer literacy as preparation for later application, seen, for example, in comparisons between computer literacy and music appreciation, fits nicely within a "basic-skill" mentality that refuses to allow that fundamental knowledge is best acquired in the process of useful activity, not beforehand in useless introduction.

STUDENT LITERACY

What about the vision of a computer revolution in the schools? Although there is a host of new computer requirements, the schools offer a world of shortsighted goals, exaggerated promise, and premature pronouncements, typically in response to intense outside pressures. Despite anecdotes of success, recent observers find computers in education to be at "a stage no more advanced than Kitty Hawk,"[7] with equipment still spread so thinly as to be "considerably less than a revolution."[8] Added to these limitations are the enormous problems of untrained teachers, inadequate courseware, insufficient funds, and the wide disparity of access between rich and poor school districts. Yet promoters of computer literacy still talk of a total transformation of education for which all students must be prepared.

Computers will be useful, they tell us, both as powerful instructional aids and as catalysts for creative thinking and problem solving. Neither of these uses, however, appears to warrant the urgent, immediate attention it is receiving. Computer-assisted instruction ranges from sophisticated simulations to drill and practice. Computer simulation courseware, although exciting in concept, is still largely experimental, limited, and untested. Drill-and-practice programs, often poorly developed and thoughtlessly utilized, are most effective in catching the attention of just those disadvantaged students whose access to them is the most limited. Even where available, their long-term benefits are unexamined and doubtful, given the complexity of such students' educational problems.

In addition to computer-assisted instruction, computers in schools are said to offer new opportunities for problem solving and intellectual development, and programming languages such as LOGO are touted as capable of bringing difficult ideas within the reach of young children.[9] Despite considerable excitement, however, this work is still in its infancy and "there is little objective data confirming the contention that computer programming enhances intellectual functioning or problem-solving."[10] The truth is that "current research has only begun to scratch the surface in exploring whether what students learn by programming computers has any carryover into non-computer situations."[11] Intuitions aside, programming remains for now an end in itself, often fun and stimulating, just as often misapplied or purposeless. In any case it is hardly worth the fuss.

Given the present state of computers in education, a reasonable agenda for the schools might include funds for promising computer projects, student exposure to computers along with woodshop or cooking, a social studies focus on the idea of technological progress, and programming courses for interested students. Promoters of computer literacy, however, see things on a grander scale. Portraying themselves as pioneers on a new frontier, they translate deficiencies into challenges and call for massive support to intensify and broaden their efforts to use the computer to transform education. Meanwhile, "computer science" has suddenly become a "New Basic" in the recommendations of the Presidential Commission on Excellence in Education,[12] despite the fact that it will meet no fundamental need of students in the years to come.

WORKER LITERACY

Computer literacy might be unnecessary to students while they are in school, but it is widely believed that "computer training should be . . . basic in schools [in order to] achieve a level of literacy that workers will need to get good jobs in the years ahead."[13] Indeed, since computers are thought to be transforming the very nature of work in the information age, computer literacy is being urged as necessary for employment in general.

Recent studies using Bureau of Labor Statistics data, however, challenge these assumptions by showing that very few of tomorrow's jobs will require any familiarity with computers.[14] While millions of workers are being permanently replaced by computers and robotics, new job areas created by computer technology—those that are not exported—are typically capital-intensive, creating relatively few new jobs. Despite prevailing assumptions, only 7 percent of the new work force will involve high-tech positions for programmers, technicians, computer operators, and engineers, and any current shortages in these areas will soon be filled.[15] Most job openings in the next decade will be for janitors, nurses' aides, sales clerks, kitchen helpers, and truck drivers. None of these jobs requires any familiarity with computers, however much they might depend upon computers behind the scenes. In addition, the vast majority of workers who will need to know something about computers, such as travel agents, airline reservationists, or telephone operators, will be able to learn what they need to know about their particular machines in a few weeks or less. In fact, the computer industry itself has begun to question its own workers' need for computer literacy, which, it says, can be developed on the job.[16]

Why then is computer literacy considered so important for employment? One answer is that computer literacy represents high tech and the assumption is made that jobs in any age of high technology will require high-technology skills. Historically, however, the "higher" the technology introduced into a job, the lower the skills required by that job become. In numerical control machining, checkout scanning, or word processing, for example, most of the competence is built directly into the machines themselves. Smarter machines require less-skilled workers.

A second answer involves the assumption that any job touched by the computer is thereby transformed into "mind work" or "knowledge work" typical of tomorrow's jobs. According to this view, "future workers will need the conceptual basis for solving complex problems and handling large systems of information."[17] Once again, the opposite is closer to the truth: Those jobs affected by computers, even attractive jobs like programming,[18] are being subjected to new, tighter forms of control and segmentation that transform them into what might be more appropriately called "mindless work."

Computer literacy does not prepare people for potent, intellectual work, but even if it did, such work will be rare in tomorrow's labor market. There is instead every indication that computers will be used to preserve existing relations of knowledge and power on the job rather than to disturb them, and that there will still be little room at the top.

Of course, corporate managers, small businessmen, and professionals will probably need to know something about computers to perform their transformed tasks, but these people usually learn specific packages on particular machines as the need arises. General computer literacy is almost worthless in this context and will be even less useful as computer systems become more user-friendly (in fact rather than promise) in the wake of Apple's Lisa, which is claimed to reduce instructional time from forty hours to forty minutes.[19] The need for computer literacy is therefore questionable even for the few attractive jobs in tomorrow's work force; for everyone else, it is unquestionably a waste of time.

CITIZEN LITERACY

What about the argument that computer literacy is necessary for citizenship? Will tomorrow's citizen need to know something about computers in order to make informed decisions in the information age? One reads that "some understanding of computer programming is necessary for the exercise of the rights and responsibilities of citizenship."[20] But this claim is difficult to understand, given the emphasis in computer-literacy education on trivial technical competence. Even if expertise in computers were necessary for informed policy decisions about their design or use, the level of technical knowledge offered in computer literacy classes is many orders of magnitude removed from the understanding of large systems that could conceivably contribute to public deliberation.

Technical understanding or expertise, however, is not necessary for participation in the social control of computer technology. Instead, one needs political understanding and a knowledge of who controls the direction of computer policy, for what purposes, for whose benefit, and for whose loss. There is nothing in computer-literacy education that offers such information or insight. Instead, discussions of "social" questions are typically underplayed and oversimplified, serving as testimonials to such wonders as the automated office, the unmanned factory, and the Star Wars arsenal. The uncritical manner in which these topics are typically taught, especially in teacher-training workshops, reduces the dissemination of computer literacy to instances of the blind leading the blind on matters of social importance.

Still we are told that "to function effectively as citizens, we will need to know how the computer impinges on and enhances our everyday lives."[21] One must ask, however, how much citizen participation has been involved in the introduction of computers into our homes, our schools, and especially our jobs, up to this point. One must then ask to what extent technological decisions are likely to be subject to democratic processes, with or without a computer-literate electorate, in the future. Such decisions are now typically made in corporate or military boardrooms, far removed from public scrutiny, and there is nothing in computer literacy that will magically empower voters to alter the locus of this control. Despite talk of computers' being used to decentralize control and to offer the public unlimited access to information, there is every indication that computers are being used to further concentrate political and economic control in the hands of a few, and that the information age will mean more information for those few and far less for the rest of us. In fact, information that is now readily available to the public at no cost will soon be coming with a price tag as libraries are transformed into information brokers and videotex becomes an exclusive information resource.

Most important of all, critical debate about the social impact of computers has diminished and discussions about their toll in human values and dignity have become unfashionable, just as computer literacy has become widespread. Truly informed citizens, it seems, will not need to be computer literate in order to participate in decisions about computer technology; they will need something else.

COMPUTER LITERACY AS IDEOLOGY

It is not especially difficult to show that computer literacy is unnecessary for consumer, student, worker, or citizen in the information age. What is difficult to explain is the prevailing assumption that computer literacy *is* essential, despite the evidence to the contrary. While most people have not stopped to examine the evidence, it is nevertheless unclear how they arrived at such an assumption in the first place. What has apparently convinced an entire population that something as vague and worthless as computer literacy is essential to their lives? Why are otherwise thoughtful and intelligent teachers, journalists, labor leaders, and politicians so innocently and unthinkingly endorsing, even helping to disseminate, such pedagogical chicanery?

Cynics point with some validity to the exaggerated promotions of the computer industry as the source of this assumption. But computer merchants and manufacturers have for the most part simply exploited and enlarged on a demand that was already there. Educators, too, have been accused of exaggerating the importance of computer literacy, but they are primarily responding to pressure from parents who are concerned that their children be prepared for what they see as tomorrow's world. What amounts to a blind faith in computer literacy cannot be traced back entirely to merchants, educators, or parents, who are themselves caught up in the same assumption about the importance of computer literacy. Instead, there is something resembling ideology in all of this, an unwitting compliance, among promoters and initiates alike, with the ubiquitous imperatives of high technology: the promise of a part in a brighter economy and a grand new social order. Computer literacy seems so plausible precisely because it fits so nicely within this futuristic ideology. It might be instructive, therefore, to view the computer-literacy phenomenon not as education at all, but rather as a campaign to further envelop the population in this ideology.

The theme underlying this campaign can be extracted from the words of its most vocal advocates: Computer literacy, we are told, "leads to a favorable affective orientation"[22] that enables people to "take reasonable positions on information-related issues,"[23] "help[s] them understand the concept of compromise with respect to policy issues such as informational privacy and security,"[24] and "eliminate concerns . . . about automation in general."[25] Viewed as an ideological campaign, computer literacy seems designed to elicit public support for the present directions of computer technology. We shall see that such an interpretation contributes to a better understanding of the computer-literacy phenomenon.

Throughout the country, a small army of business leaders and educators is spreading the word about the dangers stemming from the scientific and technological illiteracy of the American people, warning that the public is not intellectually prepared to support this country in the transition to a high-technology society.[26] These leaders express their concern over opinion polls showing the public to be skeptical of technological solutions to social problems. They argue that a scientifically literate population, one knowledgeable in science and technology, would be more supportive of their high-technology prerogatives, and they call for a renewed emphasis on science and mathematics education to generate this support.

Computer-literacy education might best be construed as part of this same campaign. While its advocates tell us that their goal is to help the public become "computer comfortable," their sights seem instead to be on a population, comfortable or not, that will support the idea of an information society: "In the coming years we are going to retool our industry, and it should be made clear that we must, at the same time, retool ourselves."[27] Since, as we have seen, there is no great need for our technical retooling, this can only mean an ideological retooling, an adaptation to the imposed imperatives of high technology.

How does a computer-literacy campaign translate into support for high-technology policy? It does so in three ways. First, the form the campaign takes—its rhetoric, its intensity, its ubiquity—persuades the population that its description of the future is the correct one. Second, the content of the instruction itself—its technical emphasis, its oversimplification of issues—eases the public into "appropriate" ways of thinking about the new technology. The third, and perhaps the most effective, means of ensuring public cooperation is the rapid institutionalization of computer literacy through the premature installation of new requirements for schooling and jobs, which literally forces the population to accept a new set of dubious realities. As we look at the form, the content, and the institutionalization of computer-literacy ideology, the heretofore disjointed landscape of the computer-literacy phenomenon begins to make sense as a coherent whole.

FORM

Ironically, the urgency surrounding computer literacy has heightened the very apprehension about computers it is supposedly designed to relieve, for although there has been a strong positive public response to computer literacy, it seems to reflect above all a fear, a panic even, of being left behind by the "computer revolution." Computer-literacy promoters have fed this anxiety with warnings that "ignorance of computers will render people as functionally illiterate as ignorance of reading, writing and arithmetic."[28] Individuals have in this way been driven to become computer comfortable by being made to feel acutely uncomfortable about their unfamiliarity with computers. This unfamiliarity, heretofore the benign consequence of intimidation, disinterest, or disdain, has become infected by the urgent necessity of computer literacy and has been transformed into a full-blown fear of computers. "Computerphobia," by no coincidence, has taken on epidemic proportions just as its "antidote," computer literacy, has become available. The consequence of all this diseased emotionality is that the majority line up to take the "cure" and those left behind are seen by themselves as well as by others to be regressive relics of a suddenly distant past, their competence, their skills, their years of experience suddenly irrelevant.

Alongside this psychological layering, arguments and justifications, invalid yet persuasive, exhort consumers, students, citizens, and workers to prepare themselves for inevitable changes soon to take place in their lives. The omnipresence of the computer is used to dramatize a sense that we are in the throes of a computer revolution that will ultimately improve our society, and the routine confusion of the future with the present serves to convince the population that the information age is already upon us and therefore beyond our control. Interestingly, the very fact that there is a campaign to help people become computer literate plays a part in the dramatization of this inevitability, quite apart from any justification; for if the information age were not on the horizon, there would be no apparent reason for all this talk about computer literacy. The inevitability of a computerized society, whether it be ultimately good or bad, is by far the most important message of the computer-literacy ideology, providing, when all else fails, its argument of last resort: "It's too late to stop it."

The least defensible, yet for many the most convincing, feature of the campaign for computer literacy is its nationalistic rhetoric: "A computer-literate workforce is necessary to maintain our national defense and to improve our national productivity,"[29] we are warned, and therefore "the shortage of computer specialists and knowledge workers has raised the problem of computer literacy to the level of a national crisis."[30] Rather than examine this presumed importance of computer literacy to the nation's needs, we are encouraged instead to assume "an overarching national goal: to reverse the trend of decline of the U.S. relative to its main competition in productivity, prestige and leadership."[31]

Apparently, the current economic recession, fostering daily comparisons between ourselves and the Japanese, is the perfect mixture for such patriotic stirrings, and there is little wonder that it stifles thoughtful debate about the legitimacy of computer literacy and other high-tech solutions.

CONTENT

Focusing on the technical content of computer-literacy curricula encourages the twin mythology that high-tech jobs require high-tech skills and that high-tech politics requires high-tech expertise. The technical focus shifts attention away from social questions and portrays computers as something to learn rather than something to think about. The computer is portrayed as friendly and accessible ("Your computer likes you") and the user is encouraged to think that all computers, even those in large systems, are friendly and accessible. In this manner, computers are further mystified in the very act of demystification. Most important of all, such technical training "is a concrete basis for understanding the value of computers . . . and leads to greater acceptance of other societal applications as well."[32]

The focus on the technical also leads the user to a false sense of empowerment, "a pseudocontrol." "When you program a computer, you feel a great deal of control and mastery" because "to program a computer is to enjoy power."[33] This sense of power attracts many people to the computer, but it also deludes them into thinking that they are somehow participating in the forward momentum of computer technology when in reality they are only conforming their intellect to the configurations and constraints of computer instruction, which constitutes a new variation of "following orders." The result is a nation of citizen "computer-masters" who cannot see the forest for the trees, a perfect support system for computer technology.

The content of the social component of computer-literacy curricula serves to depoliticize debate by defining the parameters of acceptable discussion. The establishment of a carefully delineated, "safe" arena for discussions of social impact—always understood as a "break" from the real, that is, technical, focus—renders any attempt at genuine, sustained criticism illegitimate, even irrational. Above all, the public is encouraged to assume that all the important social questions have been sufficiently investigated when in fact they have been barely entertained.

INSTITUTIONALIZATION: IDEOLOGY MADE CONCRETE

As the form and the content of the campaign for computer literacy encourage support for the computer age while discouraging dissent, the population is steadily being "retooled" to fit the ideological needs of a retooled economy. Using the terminology of the technologists themselves, we might say that computer literacy is the human-factor component in the design of the information society, used to "manufacture" a computer-friendly population that is prepared to meet new user-friendly machinery halfway. Of course, most educators, businessmen, and technologists promoting computer literacy are merely unwitting participants in such ideological designs; they simply see computer literacy as a reasonable introduction to the use of an exciting new tool. There are others, however, on the national level, whose motives seem more consciously ideological.[34]

The fact that the diverse pedagogical intentions of the former fit so nicely within the ideological designs of the latter suggests that computer literacy-ideology is more hegemonic than conscious. This is confirmed by the observation that excitement over the use of the new tool is almost always accompanied by fantastical predictions of social transformation. But the best illustration of this hegemony in operation is the rapid, almost reflexive, installation of computer requirements for schooling and employment.

"The real measure of a revolution," we are assured, "is not its casualty count, but its effects on the survivors."[35] Nevertheless, computers are being used in ways that are creating a growing underclass of displaced and marginal workers. The institutionalization of computer requirements can be seen as a means—perhaps still unconscious and hegemonic—to justify those lost lives by a process of mass disqualification, which throws the blame for disenfranchisement in education and employment back on the victims themselves.

The campaign for computer literacy includes more than rhetoric and simplistic instruction; it also consists in the accelerating installation of barriers to schooling and jobs by way of credentials and hiring practices. Throughout the country, states and local districts are falling in line by establishing and standardizing high school graduation requirements in computers,[36] and colleges and universities are following the lead of Carnegie Mellon in requiring students to own their own microcomputers.[37] We are told that "teachers should be required to be computer literate before graduation [and that] knowledge of computers [should be] a criterion for employment as well."[38] Help-wanted ads for service jobs have begun to affix the recommendation "computer knowledge helpful," and magazine cover images of hard-hatted steelworkers hunched over computer keyboards serve notice that the way to a job is through computers and that he who avoids this route will have only himself to blame.

This newly manufactured need for computer literacy in order to obtain a job or get through school defies the truth that there is in fact no genuine reason to know about computers in school or in most jobs. The "need" for computer literacy has become a self-fulfilling prophecy, based not on reality but on appearance. This explains why students in poor school districts with little access to computers are in danger of becoming disenfranchised. It is not because knowledge of computers is important; rather, it is because computer credentials are now *seen* as important, and have become a needless barrier, a biased obstacle, to opportunity. Thus, a useless parcel of information about computers might determine who gets the high-tech job at the video display terminal tomorrow, just as spelling on an application determines the right candidate for a janitor's job today. Those who are already seen as marginal to the economy, often because of functional illiteracy resulting from second-rate schooling, seem destined to become doubly disqualified by being computer illiterate as well (despite the negligible difference between computer illiteracy and its opposite).

Since the new high-tech economy will involve fewer and less meaningful jobs, this installation of barriers, this reflexive concretization of ideology, will ensure that fewer applicants make the grade; computer-literacy ideology, with its own built-in justifications, will result in mass disqualification. By intensifying the already frantic competition for schooling and jobs, by reducing the numbers who will get through, and by justifying the exclusion of those who will be left behind, computer barriers impel a people to adapt themselves to the computer society, regardless of whether they are destined to become its "survivors" or its "casualties."

Knowing something about computers, tools that are apparently being used to reshape our world, would seem to be superior to remaining ignorant of them; the ideal of a technologically informed citizenry in a technological age makes sense as well. But when one considers how education for computer literacy enfeebles in the name of empowerment, mystifies in the name of demythology, and disenfranchises in the name of participation, the questions must be asked: Is it even possible in the current ideological climate to provide a potent pedagogy about computers? Is it possible to teach about computers without at the same time exaggerating their importance and without depicting their use as the highest form of intellect? Is it possible to avoid hegemonic interpretations that automatically translate the omnipresence of computers into a mythical futurism called the "information society?" Perhaps creating the space for such possibilities should become a priority among serious educators, leaving computer literacy to the ideologues. And since the computer-literacy phenomenon is but one thrust in a larger campaign to accommodate the American people to the erstwhile imperatives of high technology, our focus should perhaps be directed to this larger campaign, anticipating its further incarnations.

In recent months, for example, computer literacy has been viewed with growing disfavor, and some business leaders and educators have suggested replacing its narrow focus with a more general "basic" education, one that emphasizes critical-thinking skills, which, they say, will better prepare people to adapt to a constantly changing job market.[25] Although this appears to be a reversal of attitude toward computer literacy, it can easily be seen as a continuation of the same ideology. Since the new economy will require minimal intellectual functioning from the majority of workers, "adaptability" offers new justification for old "basic" educational policy in an economy that will no longer need many educated people. In this context, the clarion call for higher standards in the name of "excellence in education" is simply an excuse to further intensify the selection process for a streamlined economy. Most important of all, such education is still an enterprise, like computer literacy, that only further adapts a people to a world and to a future that is not of their own making.

Notes

1 Sherry Turkle, "Computer as Rorschach," *Society*, January/February 1980, p. 15.

2 Daniel Watt, "Is Computer Education Out of Control?" *Popular Computing*, August 1983, p. 84.

3 Quoted in "The Computer Moves In," *Time*, January 3, 1983, p. 28.

4 Ibid., p. 16.

5 "The Computer Moves In."

6 "Get the Jump on Tomorrow's Jobs," *Changing Times*, August 1983, p. 30.

7 "American Education: The Dead End of the Eighties," *Personal Computing*, August 1983, p. 105.

8 Ibid., p. 105.

9 See Seymour Papert, *Mindstorms: Children, Computers and Powerful Ideas* (New York: Basic Books, 1980).

10 Peter Coburn et al., *Practical Guide to Computers in Education* (Reading Mass.: Addison-Wesley, 1982), p. 30.

11 Daniel H. Watt, "Education for Citizenship in a Computer-Based Society," in *Computer Literacy: Issues and Directions for 1985*, ed. Robert J. Seidel et al. (New York: Academic Press, 1982), p. 62.

12 National Commission on Excellence in Education, *A Nation at Risk: The Imperative for Educational Reform* (Washington, D.C.: U.S. Government Printing Office, April 1983), p. 26. This overnight identification of computer science as a basic skill offers a firsthand example of the ideological birth of a basic skill; it should raise our suspicions about the equally ideological origins of the more traditional basics, such as the three R's.

13 Marvin Cetron, quoted in "Get the Jump on Tomorrow's Jobs," p. 30.

14 See especially Henry M. Levin and Russell W. Rumberger, "The Educational Implications of High Technology" (Stanford: Institute for Research on Educational Finance and Governance, February 1983), p. 3. See also Bob Kuttner, "The Declining Middle," *The Atlantic Monthly*, July 1983, pp. 60, 61.

15 Levin and Rumberger, "The Educational Implications of High Technology," p. 5.

16 "Schooling in 'Basics' Must Precede Computer Literacy," *Education Week*, June 15, 1983, p. 8.

17 Watt, "Is Computer Education Out of Control," p. 86.

18 See Philip Kraft, *Programmers and Managers: The Routinization of Computer Programming in the United States* (New York: Springer-Verlag, 1977).

19 "The Year of the Mouse," *Time*, January 31, 1983, p. 16.

20 Coburn et al., *Practical Guide to Computers in Education.*

21 Ronald E. Anderson, "National Computer Literacy, 1980," in Seidel, *Computer Literacy*, p. 13.

22 Andrew Molnar, "Key Components for a National Computer Literacy Program," in Seidel, *Computer Literacy*, p. 13.

23 J. C. R. Licklider, "National Goals for Computer Literacy," in Seidel, *Computer Literacy*, p. 282.

24 Ibid., p. 284.

25 Kenneth E. Brumbaugh, "Computer Literacy: 1985," in Seidel, *Computer Literacy*, p. 295.

26 See, for example, Edward B. Fiske, "New Priority: Technological Literacy," *The New York Times*, Spring Education Survey, April 23, 1983. See also the Science and Mathematics Special Supplement in *Education Week*, July 27, 1983.

27 Licklider, "National Goals," p. 282.

28 Donald Michael, quoted in Edward Fiske, "Computer Education: date '83," *Popular Computing*, August 1983, p. 94.

29 Molnar, "Key Components'" p. 3.

30 Ibid., p. 4.

31 Licklider, "National Goals."

32 Robert J. Seidel, "On the Development of an Information Handling Curriculum," in his *Computer Literacy*, p. 24.

33 Sherry Turkle, quoted in "Computers: Threat to Family?" Rochester *Times-Union*, January 8, 1983.

34 Two prominent examples: The Human Resources Research Organization (HumRRO), a major recipient of computer literacy grants and convenor of national conferences, has been funded by the Department of Education to formulate a "working definition" of computer literacy by 1984. Since HumRRO was founded by the Army in 1951 in order to "improve human performance through behavioral and social science research" (*Encyclopedia of Associations*, vol. 1 [Detroit: Gale Research, 1983], p. 421), one might ask in whose interest such a definition will be "working."

Andrew Molnar of the National Science Foundation, a leading national figure in computer literacy, wrote the U.S. Army Pamphlet 55-104 entitled *Human Factors Considerations of Undergrounds in Insurgency*, in which he asserts that "the most effective countermeasure is the use of immediate, overpowering force to repress the first signs of insurgency or resistance. Nations with a representative or constitutional form of government are often restrained from such action by moral, legal and social considerations" (p. 65). One wonders how such views are incorporated in his concern about "The Next Great Crisis in Education—Computer Literacy," the title of one of his more recent works.

35 Joseph Deken, *Electronic Cottage* (New York: Morrow, 1981), p. 2.

36 *Education Week*, February 26, 1983.

37 *Time*, January 3, 1983, p. 24.

38 David Morsund, quoted in *Education Week*, November 17, 1982, p. 16.

39 See "Schooling in 'Basics' Must Precede Computer Literacy." Also see Levin and Rumberger, "The Educational Implications of High Technology," pp. 11-13.

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Computers and kids

I. Reinecke

Source: I. Reinecke, *Microcomputers*, Penguin, Ringwood, Vic., 1983, pp. 159–73.

When the teenage hero out-witted the central computer, which controlled America's defence arsenal, and saved the world from nuclear devastation, a sigh of relief and admiration rippled through Sydney's George Street Hoyts cinema. The film was *War Games*, a celebration of the mastery of microcomputers by children. Its hero had tapped into a data base he thought contained the video game programs of a Californian software manufacturer. Instead his microcomputer was talking to the most sensitive computer in the US defence network, and the game he began to play was simulated nuclear war which crossed the boundary from fantasy to reality. At the moment when all seems lost as the defence computer, called WOPA, is about to provoke a global conflict, the young hero takes over a keyboard to punch in instructions that avert the crisis. A few weeks after the film was released in Australia, a group of amateur microcomputer enthusiasts in the US were charged by the FBI with gaining unauthorized access to government data bases. One of them was the US Nuclear Weapons Research Laboratory in Los Alamos, New Mexico. It was great publicity for the film.

The synthesis of computers and kids is the most important image unleashed by microcomputers. Buyers between the ages of six and seventeen dominate sales of cheap microcomputers and the games programs which are sold for them. In the boom year of 1982, the games company Mattel sold seven million computer consoles in the US, and that was only a quarter of the total that year. In the same period, Atari sold twenty million games cartridges to be used on microcomputers, and Mattel sold twelve million. The video games market in 1982 was estimated to be worth $2 billion in the US, including machines and programs, a growth rate of 90 per cent on the year before. Machines designed to be used for games were estimated to be in 12 per cent of all American homes by the end of 1982, and a survey revealed that they were being used an average of more than twelve hours a week. Games were the predominant activity for computers in the home, accounting for 60 per cent of the time they were used. Less than 20 per cent of the time they were being used for what was described as educational purposes. Home accounting and retrieval of information from data bases represented 10 per cent each.

Kids are used constantly in television and press advertising of microcomputers. Machines are described as so simple that an eight-year-old could operate them and television commercials show kids running offices with the aid of microcomputers. The imagery of children and computers is given additional force because if it were not for the acceptance of computer games by youngsters, microcomputing would have had a much less friendly public image. The association of children and microcomputers is reinforced by the successful kids who are writing and publishing software, mostly as a hobby. But if microcomputers had been represented simply as ways of having fun, many fewer would have been sold. Microcomputers are presented as educational tools, without which no child can be given a fair chance of achieving personal development and permanent employment.

Predictions about what the future will hold are littered with high technology equipment and systems. The future is depicted in terms of automation in offices and factories, electronic cottages and instant data on computer screens in the home. Parents with the means to do so find it almost irresistible to give their children a head start. Those who can afford it are mostly middle class, white collar and can be classified as information workers. They are willing converts to the thesis that microcomputers are beneficial to kids and accept the notion that computer literacy is necessary in education. They encourage schools to buy computers instead of books, so that their children will not be left behind in the stampede towards the high technology society. So indiscriminate is their endorsement of computers for kids that their judgement of what is educationally good for their children ignores the reservations some educators have about the new relationship between computers and adolescents.

Children mostly use microcomputers to play games. There are schools which challenge that proposition, claiming that their students use the machines for educational purposes. The sales figures do not bear them out nor does the imbalance of video game software on the market compared to educational programs. Even the slump in the sales of microcomputer consoles on which games are played confirms that their main buyers are children. Fashions move quickly in markets for consumer goods aimed at youngsters. Confronted with evidence that the overwhelming desire of children given the chance to use a microcomputer is to play games on it, some educators claim that playing and learning cannot be divorced. Computer games, they argue, are an excellent way for children to learn new skills and develop their talents. The more important question is what skills and values are imparted in the process.

The type of skills which microcomputers are most often claimed to develop are those of co-ordination and rapidity of movement. Anyone who watches children play a hand-held electronic game or observes their efforts in games arcades can hardly doubt that kids acquire an extraordinary facility to match eye and hand movements. Many adults find that their slower physical reactions make them easy prey for skilled and much younger computer games players. There are, however, simpler and less expensive ways of developing those sorts of skills without using electronic equipment. Organized sport is one way but so are less formal activities such as throwing and catching objects, riding bicycles and running and chasing. If improved motor skills were the sole benefit of computer games, it would provide a poor rationale for their mass introduction to schools in an era of limited educational budgets.

Supporters of the notion that children learn from computers things they would otherwise not point out that games which rely on speed of physical reaction are only one sort on the market. The best known of the arcade style games are Space Invaders and Pac Man, which involve co-ordinating the eye and hand. The other sorts of games have greater intellectual content because they are structured as puzzles for the player to negotiate. Hidden clues are left to guide players to their next move. The goal is often a treasure which must be reached despite the best efforts of hostile forces along the way. Undoubtedly, the capacity to think through problems, reasoning from premises to conclusions, is educationally valuable, and many children find the games absorbing.

The sorts of reasoning skills developed from puzzle games may help children to work out problems in real life, but the ability to do that existed before electronics. Whether a higher order of those skills is learned by using computer games than by reading detective novels or science fiction stories is arguable. But what is accepted among educators is that human values are imparted to children in the learning process. The debate about Enid Blyton's Noddy characters turns on that point. If Noddy is a racist, sexist character with an overweening attitude to authority figures such as policemen, those values are likely to be picked up by children reading Blyton's books. The argument that computer games are educationally valuable for children is weakest when the content of those games is analysed. Noddy became an issue for the values he expressed, but there seems to be a curious silence among teachers about the content of many computer games.

OziSoft is an Australian games program supplier with a number of best-selling packages that are heavily promoted in the microcomputer press. One of its games is called Paratrooper, and a summary of the plot is provided for potential buyers. It reads in part: 'You are the only one left to stop them. The sky is full of enemy choppers. Paratroopers keep dropping into your area with a non-stop barrage of enemy troops. They are out to destroy you.' The game combines the skills needed to play arcade as well as puzzle contests. Players are urged: 'You must make every shot count – don't be too fast on the trigger. Every time you hit a chopper or paratrooper you get extra points.' Another game is called Annihilator and is introduced in this way: 'Defend your moon base in this fast pace, high action game against attacking aliens who launch sophisticated heat seeking missiles at you.' A third is entitled Bug Blast, and players are tempted with this description of it: 'If you thought Centipede was fun, then shooting through the cactus with the hit-and-miss action of Bug Blast is going to inspire your imagination.'

Microbee is a popular Australian-made microcomputer which is widely used in schools, and it has a whole catalogue of games programs which schoolchildren can play on it. As well as programs which provide tutorials in machine code and word processing, software suppliers offer a range of games with names such as Ghost Muncher. Another Australian computer game supplier, Cosmic Software offers Killer Gorilla which is described in this way: 'Save the fair maiden from the clutches of the Killer Gorilla. This is a four frame game. In the first frame frame you have to jump over rolling barrels. In the second game you find yourself confronted with a conveyor belt system as well as Dancing Flames. The third frame has elevators, Dancing Flames and Bouncing Beams. The fourth and final frame has several layers held together by pins. You have to pull out all the pins before the Dancing Flames get you, or your time runs out.' Another Cosmic game is less vigorous and is called Hamburger Sam. It involves building up all the elements of a hamburger from the components such as lettuce and pickles which drop through space.

Apple computers and education have been associated since the machines were first launched, and a great number are being used in Australian schools. Among an enormous volume of computer games available for the Apple are Crime Wave, Delta Squadron, Jawbreaker, Jump Jet and Spectre. Programs written for the Commodore Vic 20 microcomputer, used by many children because it is cheap and has a wide range of software, include Abductor, Andes Attack, Laser Zone, Blitzkreig and the bizarre Attack of the Mutant Camels. Software for the Tandy TRS-80 includes Martian Menace, Deathworld, Defence Penetrator, Stellar Warp, Doomsday Mission, Alien Taxi, Desert Peril, Devil's Power and the evocative Panik! Other games which can be played on Tandy machines include The Bloodstar Conspiracy, described thus: 'President Catto has been assassinated! Blown to pieces in his own maximum security apartment. The ruthless forces of the Fearroa Empire had penetrated deeper into the Dogod Federation security system than had ever previously been feared. Now the mad child-woman Empress Fess was preparing for war. Only the experience and skill of President Catto could halt bloody interstellar conflict, but he was dead . . .'

The means used to score points in these games typically involves military weapons, and the aim is to annihilate opponents. Cosmic's Defence Penetrator sets players to launch an attack through alien territory to destroy the command headquarters of the enemy. On the way to the target, the player accumulates points according to how much destruction can be inflicted. Fuel tanks are worth 10 points, missiles count for 30, laser cannons bring 50 points, nuclear reactors between 300 and 400 and the command post itself 2,000. In the search for variations on this theme, some of the best-selling games in Australia have names such as Jump Man, Choplifter, Motor Mania, Apple Panic, Crush Crumble Chomp, Video Vermin, Spiders of Mars, Cross Fire and Astro Blitz. So pervasive are the images of threat and destruction that few popular video games do not embody them in some guise or other. One of the most exotic is called Communist Mutants from Outer Space.

Another variation on these themes involves the use of sex as a reward for achieving the set goals. Although they are not offered for open sale to children, they are known to most keen video games players. The best known is called Custer's Revenge. It involves a video battle between Indians and the US cavalry, where a figure representing Custer avenges himself for defeat in the original conflict by raping the video image of an Indian woman staked out on the ground. The game's existence became well known when some Sydney women formed a group against violence in video and picketed the Bondi Junction store of Angus and Robertson, demanding that the game be withdrawn from sale. The existence of these sorts of games is not publicized in most microcomputer magazines because of their reservations about accepting revenue from those sources. But in the US there is a larger under the counter market for them. Although most are aimed at adult players, there is little doubt that many are being played by children. Examples of the theme include a game called Soft-Porn Adventure, which sets the player the task of acquiring sufficient money to gain the services of a prostitute in a brothel.

There is an argument that, with the exception of the pornographic versions, kids are exposed to no more violence and sadism through video games than they would be if they were watching television. New York University professor Neil Postman in his book, *The Disappearance of Childhood*, has argued that such exposure has diminished the sense of being a child for many children brought up in the age of television. He argues that nothing is excluded from the child's scrutiny because portayal of adult life on television provides them with a relentless diet of murder, rape, violence, robbery, drugs and wanton destruction. Exposure on the scale meted out by television destroys the child's sense of wonder, inducing cynicism and even arrogance about human problems, according to Postman. One of the claims made for television, where viewers interact with the screen, is that it enhances the power of the medium. Cable television channels that run game shows, where a contestant's choice can be influenced by viewers at home pressing buttons to record their preference, increase the potency of television. Similar claims are made for text systems that allow subscribers to call up information on the screen, by pressing buttons, and to do their banking and shopping from home.

The difference between the passive activity of watching television and the activity of interacting with it has led to the latter being described as Television Two, a second generation of the medium more significant than the first. Video games on microcomputers resemble Television Two because the players can influence what appears on the screen and, in the process, they pay very close attention to it. To have children interacting with computer terminals is claimed to be the major virtue of teaching systems which use computers. Whereas a child is subject to a range of distractions in the classroom, restricting communication to the screen isolates the child and concentrates attention.

Children have a huge capacity to be entertained by video games, but their makers have prescribed ideas of what children might find entertaining. Roger Keating, a New Zealand school teacher who has written a number of popular video games, gave this reply to a reporter's question about the content of those games. 'I'd really like to see an idea for a peace game, but they just don't work. I can't think of a single game at the moment that isn't based on violence, because people are naturally aggressive and competitive.' The assumption that human beings are innately aggressive is one which is at the very heart of some of the most reactionary notions about what motivates people. It is certainly one of the most contentious issues in education, politics and social organization. Yet it is these values which are reflected in computer games, to the total exclusion of any other view of human activity.

Few of even the most ardent advocates of computers in education would defend video games as an end in themselves, which impart sound values and worthwhile skills. But they argue that the attraction children have for video games can be used as a bait to entice them into more educationally acceptable activities. Some education software packages attempt to combine the two strands. The large British-based book publisher, Pitman, has produced a number of educational packages based on the use of microcomputers in a series broadcast by the BBC in the UK and picked up by the Australian Broadcasting Corporation. One of the programs is called Introducing Map Skills and is described thus: 'Compass Points and Bearings provides a pictorial and progressive explanation of the importance of compass points and bearings. Yacht Race is a challenging game requiring the skills related to bearings and scales. One or more pupils aims to race a yacht around a circular lake.' Other examples include these: 'Hike is an orienteering game using distance and bearings on a map. Rail illustrates 'Weberian' location theory using the example of steel production with a hypothetical rail network.' One does not have to be a child to note the different level of excitement between Rail and Defence Penetrator.

The international market for video games is much larger than for educational software; the ratio is generally conceded to be about ten to one in favour of games. Even Apple, which has managed to make almost everything it does sound exciting to educators, fares little better than Rail and Yacht Race when it lists standard educational software available for its machines. The list includes such titles as Acid-Based Chemistry, Income Meets Expenses, Money Management Assessment, Chemistry with a Computer, Agreement of Pronoun/Antecedent, Commas and A Batch of Endings. Ian Phillips, the former school teacher responsible for the Zardax word processing program that enabled him to set up in business himself, admits that educational software lives deep in the shadow of computer games. He says frankly: 'There is not very much in the way of educational software suitable for purchase.' In 1983 his former school had set itself a budget of $2,000 to buy educational programs but found it could justify spending only $800. 'That's really very sad,' commented Phillips.

Like other programmers interested in education, Phillips points out that it is an expensive and time-consuming job to write programs for schools. Although the demand is there for video games, the level of investment required to develop good educational packages is not justified by the size of the market. It is estimated in the US that the educational software market will grow at a relatively modest rate from $60 million in 1982 to $900 million in 1987, a figure some observers regard as optimistic.

Children are subject to much more pressure to play video games than use educational programs because of marketing campaigns and the schoolboy culture that has grown up around games. It is a schoolboy and not a schoolgirl activity in much the same way as marbles, shanghais and BMX bicycles are regarded as male domains. Editor of *Your Computer*, Les Bell, has noticed a feature of that culture which has increased the popularity of video games among schoolchildren. They do not need to own a microcomputer to play the games. One of the reasons that computer magazines are not bought by as many children as their involvement in microcomputing would lead publishers to anticipate is that games are more exciting. Bell said: 'The computer produces graphics and sound and action. Kids would rather spend money on blank discs, so many kids have their own copies of discs but don't have a machine. They use the machines at school and in public libraries, and they become very acquisitive about software.' The price of entry to video games for children is not the price of a machine, nor even the price of software packages. They use blank discs bought for a few dollars and pirate copies from the original. Bell says he knows of children who have a collection of floppy discs bigger than his own software library, but they have no machine.

In some ways children have contributed to the undermining of the market for computer games by declining to accept the manufacturer's proposition that you need a machine on which to play games. Although the sales of computer consoles remain static or drop, there is continuing demand for software. But if piracy of the programs were eliminated, sales would be much higher. Ian Phillips has noticed the same phenomenon. He said: 'Piracy is so rife among the schools. We discovered a lot of kids were bringing pirated game stuff to school to play on the Apples'. Some schools have attempted to deal with this annexation of the technology by using game playing as a reward. In return for helping in the library during the lunch hour, students are permitted to play video games on the school's computer under the supervision of teachers on Saturday mornings. Some teachers regard that practice as an admission of defeat.

The challenge of writing educational software which can compete for excitement and interest with video games is largely falling to individual teachers and a small number of companies soliciting programs in the same way as video game publishers. Les Bell says: 'Educational software is in a terrible state because of lack of adequate programs.' Those who seek to remedy the problem as educators face great difficulties. To spend sufficient time to develop programs for children they must devote less attention to their teaching activities. In school systems, which are squeezed for funds, the luxury of developing good educational programs instead of teaching is an option open to very few teachers. Some of the work being done on educational programs in the US has focused on developing positive rather than negative indicators in games which are used for learning. Instead of games which punish children for making spelling errors, the programs concentrate on rewarding them for a correct answer. Another trend is to take the child out of the isolation of dealing just with a screen. Games are being developed with educational aims which involve more than one player. The action can be frozen on the screen while children discuss the next move and some instructions can only be carried out with the involvement of more than one player.

Although the development of computer programs which combine good educational values and the attraction of game formats appears likely to be slow, many machines in schools are being used to teach programming. There is an assumption that while computer games may be educationally useless or even damaging, teaching kids programming must be of greater value. Mostly the language used is Basic, which can be learned more easily than higher level languages. But even those who could expect to be most strongly in favour of teaching children programming have strong reservations about it. Ian Phillips again: 'We can teach kids how to drive a motor car in primary school if we want to. The same applies to the teaching of programming in schools; it is not really very suitable. Just because we can do so doesn't mean that we have to.' Phillips says his Zardax program is being used in schools to help remedial children read and write, but he doubts the educational value of teaching them programming. Ian Webster, the editor of *Australian Micro*, has taken a close interest in the use of computers in schools, and he shares Phillips's reservations. He describes programming courses in schools as teaching children how to drive a motor car without telling them what it means to drive cars on the roads and what sort of rules have to be obeyed. Once children are taught the elements of programming, they explore the relationship with the machine themselves; the teachers become irrelevant, he says.

To give children the opportunity of interacting with microcomputers, at anything higher than at the level they reach with Basic, requires more powerful machines than schools can afford, Webster believes. Basic is simply a way for children to issue commands to the machine and evoke certain responses. It allows only a limited potential to be explored. Webster believes the most significant event in educational software was the publication of Seymour Papert's book, *Mindstorms*. Papert developed the educational computer language Logo, which has become available in some packages for microcomputers. Webster predicts that approaches such as Papert's, which involve a much more complex relationship between computers and children, will make languages such as Basic redundant. In the meantime, the dictates of the market will prevail, as Kerry Laue of the Dick Smith organization spelled out bluntly: 'Many people talk about educational software, but the problem is you can't sell it. I could sell 100 games to every educational package I could even consider selling. The possibilities are limited in education to things like speed writing and typing training. You could produce something on fourth form geography, but first the purchaser has to be in fourth form and secondly has to be doing geography. The market is very limited for educational software.'

If the virtues of computers in education have been oversold in schools, some of the teachers involved in promoting them must bear the responsibility. Many have become willing helpers in the marketing efforts of computer suppliers, attending training courses, accepting gifts of machines and generally endorsing particular brands and models. Their argument for teaching children programming is that it offers job opportunities when they leave school. Far from being an occupation which, unlike others affected by the technological revolution, has a bright future, programming may be one of computing's job casualties. Compare the plight of punch-card operators, a new type of office worker created in the 1960s to key information on to cards which were used to prepare tapes for mainframe computers. Because their work depended on speed and accuracy, many girls fresh from school were able to earn reasonable wages as punch card operators. By the 1980s they have all but disappeared, as newer and less labour-intensive means of putting data into computers have developed. The same fate is likely to befall many of those people earning their living as programmers.

Most programmers are engaged not in devising innovative software for video games but in the more routine activity of developing programs for business use. Many of them are employed by large institutions that need programmers to write or modify software run on large computers. The availability of package programs for minicomputers was part of the suppliers' marketing strategy. The increased use of packages in business for minicomputers and microcomputers has undoubtedly reduced employment opportunities for programmers. The techniques now favoured in programming, described as modular or structured approaches, have also diluted the labour content in preparing programs. Instead of a programmer writing each line of code, blocks of prepared software are inserted as the program is prepared. Although this approach saves time and reduces cost, it also means that less programmers are needed to perform the same amount of work. Other techniques, such as program generators, which enable those unskilled in software to prepare programs using plain English commands, also affect the number of jobs for professionally trained programmers.

The job prospects of computer programmers who perform the less well-paid functions in computing are certainly dimmer than those for plumbers. Even if children did not intend to become plumbers for a living, acquisition of some skills in the area would prove a distinct asset around the house. Yet anyone who put forward the idea that children ought to be taught plumbing instead of computing - on the grounds of utility and increased job opportunity - would be regarded as eccentric.

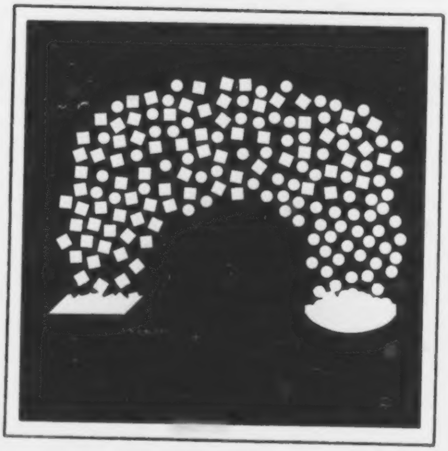
Most children will grow up to work in jobs which may involve contact with computers, but they will be users of the machines rather than those who make them work. Even if they do not use the machines directly, they will work in places where their occupations are defined by technology.

In the office and factory, computers will increasingly dictate how work is done and what sorts of jobs people will have. Few schools have passed beyond the consumer stage of installing computers, to the pleasure of parents and teachers, who see the machines in terms of career advancement, and to the delight of children, who see the promise of more exciting lessons. Hardly any schools tackle seriously the issue of how computers will affect society beyond regurgitating high technology platitudes. Forming attitudes and policies which ameliorate the unemployment created by computer technology and its effects on skills is one of the most pressing social needs. In the rush to clamber aboard the bandwaggon pushed by microcomputer suppliers, this priority has been elbowed aside in almost all schools.

The very best weapons that children can have in the future may be quite old fashioned. They may be the ability to comprehend, compare, evaluate and question in the process of reaching judgements. Consider the sort of child Neil Postman believes may be created by the age of television ‘. . . the calculus of wonderment changes. Curiosity is replaced by cynicism or, even worse, arrogance. We are left with children who rely not on authoritative adults but on news from nowhere. We are left with children who are given answers to questions they never asked. We are left, in short, without children.’

How much more potent are video games than television, reinforced as they are by consumer marketing and advertising and uncritical acceptance of microcomputers by parents and teachers? The virtues of print literacy, of being able to read, learn, discuss and ask questions within a human rather than a technological framework have already begun to suffer. Microcomputers, programmed to question the effect of the widescale introduction of computers in schools, may well be the most valuable use of that technology. In the meantime, those questions will still need to be thrashed out in the arcane world of human discourse. Amid the hubub of excitement about microcomputers in education, that forum is currently almost silent.

Annotated bibliography



Ellul, J. *The Technological Society*, tr. J. Wilkinson, Alfred A. Knopf, New York, 1964.

Ellul, J. *The Technological System*, tr. J. Wengroschel, Continuum, New York, 1980.

In *The Technological Society* Ellul sets out the case that technology will assume a stance which is independent of human control. This theme is developed in his later book, *The Technological System*. In this book Ellul expands on the idea that technology is completely autonomous from human intervention. Indeed, nature has been replaced by technology to become the prime environment of people. Further, he argues that problems in the world are now defined as technological problems which determine the direction of social, political and economic concerns. These are significant books which have had an important impact on the study of technology in our society.

Game, A., & Pringle, R. *Gender at Work*. George Allen & Unwin, Sydney, 1983.

This volume is an important contribution to the ongoing debate concerning the gender relations inherent in the workplace. While technology may have been used to accentuate the patriarchal divisions in society Game & Pringle argue that this does not have to be so. They point out that the basis of the sexual divison of labour is most vulnerable during a period of technological change. It is at this point that the sexual division of labour is open to challenge. Through a number of case studies the authors provide insights on the gender relations of the work place.

Hill, S., & Johnston, R. (eds). *Future Tense? Technology in Australia*. University of Queensland Press, St Lucia, Qld, 1983.

In this book Hill & Johnston have compiled a series of essays which examine technology and social change in Australia. In particular, they look at the consequences on the economy of the use of technology with regard to education, the work environment, unions, management and the unemployed. Students should read Ron King's 'The relationship between technological change and education', Ron Johnston's 'The control of technological change in Australia', and Keith Windschuttle's 'Technology and unemployment'. This is an important Australian book.

Jones, B. *Sleepers, Wake! Technology and the Future of Work*. New edn. OUP, Melbourne, 1983.

Jones places the development of technology within a historical context. He argues that the current levels of technology have reached a point where either massive unemployment may be perpetuated or low-skilled service sector work for the majority will be created. However, he is optimistic that new approaches to these problems will lead to a new creative era.

Mensch, G. *Stalemate in Technology: Innovations Overcome the Depression*. Ballinger, Cambridge, Mass., 1979.

Mensch relates technological innovations to the long wave cycles which some scholars argue the world economies have experienced. He argues that technological change takes place in clumps or swarms, especially during a depression. At this time old technologies have run down, thereby providing the creative opportunity to develop new areas of inventive and innovative activity.

Noble, D. F. *America by Design: Science, Technology and the Rise of Corporate Capitalism.* Alfred A. Knopf, New York, 1977.
In this book Noble examines the role of the engineer as an employee of capital in the application and growth of modern technology as well as in the rise of corporate capitalism. His main argument centres on the proposition that engineers were directed to use their skills to ensure profit maximisation, labour savings and managerial control, rather than the humane and collaborative organisation of the workplace.

Reinecke, I. *Microcomputers.* Penguin, Ringwood, Vic., 1983.
Reinecke provides a series of questioning propositions in this book which closely examine the basis of the euphoria with which the recent 'gee whiz' technology has been greeted in our society. He claims that the high skill level assumed in working new technology is only illusory. More importantly, though, he argues that this illusion has masked the way that new technology produces and reproduces the unequal class relations of our society. This is a very powerful and important book.

Rosenberg, N. *Inside the Black Box: Technology and Economics.* CUP, Cambridge, 1983.
This volume is a collection of essays which have been published or presented elsewhere. However, the bringing of these papers together allows us to attain a clearer idea of Rosenberg's central thesis on technological change. This central thesis is that economists have consigned technological change into a black box which is not worthy of serious investigation. He attempts to change this situation by examining technology and technological change in detail.

van Duijn, J. J. *The Long Wave in Economic Life.* George Allen & Unwin, London, 1983.
This is an excellent book which examines the intellectual legacy derived from Kondratieff which proposes a theory of long wave economic development. In relating technological change to long wave theory van Duijn argues that because technological change is often thought of as an autonomous force which is uncontrollable the role of the innovator is frequently conveniently forgotten. In his interpretation the long wave approach attempts to put a human and historical face on technological change.

Winner, L. *Autonomous Technology: Technics-out-of-control as a Theme in Political Thought.* MIT Press, Cambridge, Mass., 1977.
Winner argues that the technologies which we have invented have got to such a stage that we have lost mastery over our own creations. Through the development of technology the autonomy of human beings declines. The consequence is that technological progress has a certain inevitability and is now out of control. This is an important book which raises significant issues with regard to technological change.

About the author

Peter Watkins had been a teacher in the Victorian Education Department for twenty years before joining Deakin University. He completed an MEd in educational administration at Monash University, studying the power relationships in five technical schools. He then commenced doctoral studies, and completed his PhD at Deakin in 1982. The thesis examined a Year 11 group's perceptions of work before and after going out on work-experience. His main interests are the relationships between school and work, organisational power; workplace democracy; and the development of a critical analysis of organisations.

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